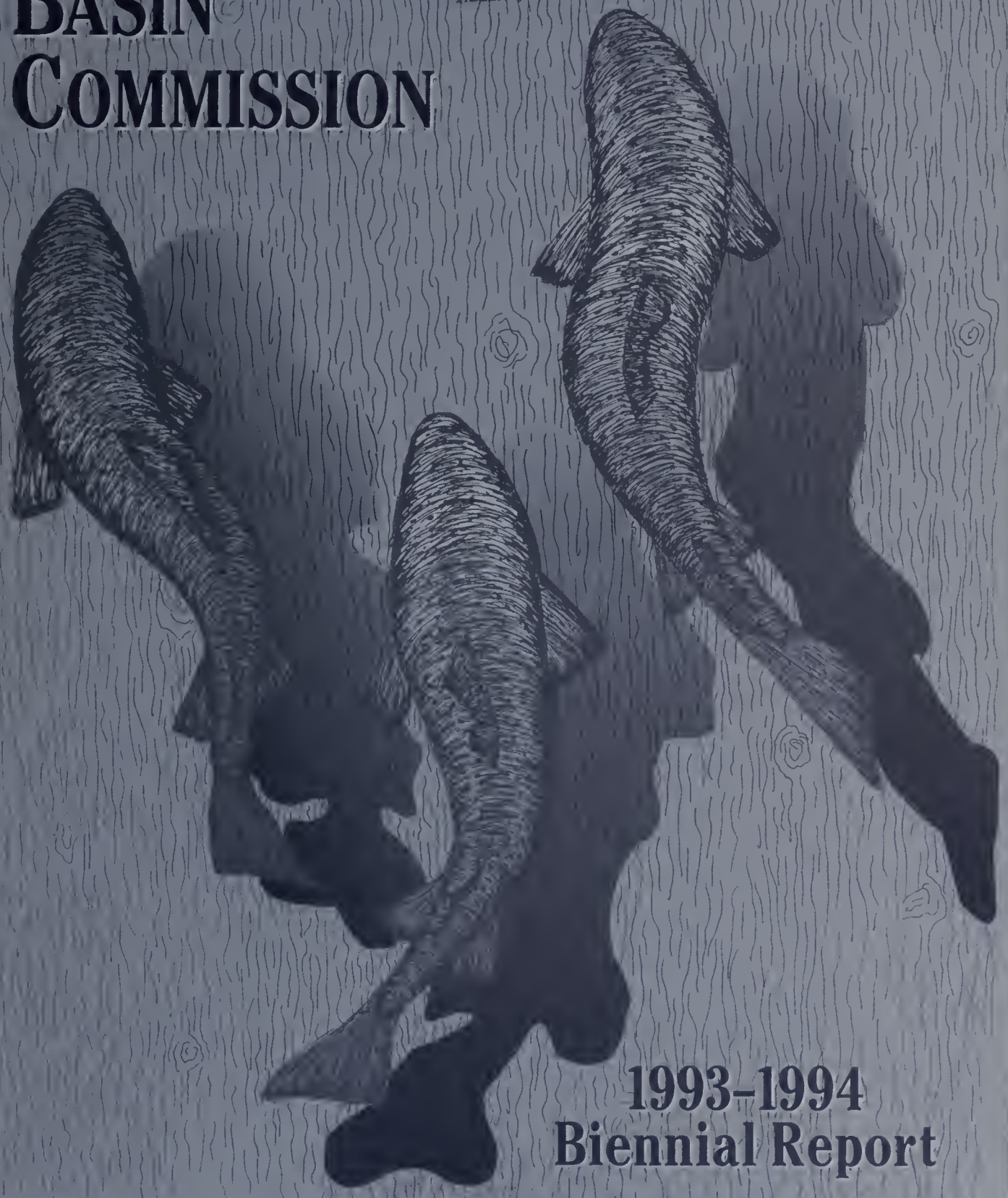
FLATHEAD BASIN COMMISSION



1993-1994 Biennial Report

CONTENTS

2	**Letter from the Chair**	
3	**The Flathead Basin**	
4	**The Commission in Action**	
5	**A Dynamic Commission**	
6	**Education, Information and Recognition**	
	6	Public Education
	7	Issues Monitoring
	8	Crown of the Continent Ecoregion Workshop
	9	Flathead River Partnership
	9	Awards and Recognition
10	**Bilateral Cooperation and Planning**	
	10	Land Use Trends in the Flathead Basin
	10	Population Trends
	10	Planning Efforts
13	**Scientific Round Table**	
13	**Hazardous Materials**	
14	**Watershed Planning**	
15	**Monitoring**	
	15	Monitoring Master Plan
	16	Fisheries Mitigation
	16	Waste Water Treatment
	17	Volunteer Monitoring Program
	16	Groundwater Coordinating Committee
18	**Water Quality Monitoring Status Report**	
	18	Executive Summary
	18	Background
	20	Water Quality in Flathead Lake and its Tributaries
	24	Water Quality in Headwater Streams
	28	Lower Flathead River Basin
	29	Fisheries
	32	Forest Practices Update
	32	Private Sector Activities
	34	PCBs in Flathead Waters
	34	Conclusions and Recommendations
37	**Appendix**	
	37	Establishing Legislation
	39	Glossary of Terms
	42	Commission Membership
	44	Commission Budget
	45	Scientific Report Section

LETTER FROM THE CHAIR

Dear Governor Racicot and members of the Legislature:

The Flathead Basin Commission was established by the 1983 Legislature and provided with clear direction on what its purpose was to be and charged to perform three distinct duties in carrying out that purpose.

The very clear purpose is to "protect the existing high quality of the Flathead Lake aquatic environment, the waters that flow into, out of, or are tributary to the lake; and the natural resources and environment of the Flathead Basin."

The duties we perform to carry out that mandate are equally clear.

It is required that the Flathead Basin Commission "coordinate development of an annual monitoring plan, encourage close cooperation and coordination between federal, state, provincial, tribal, and local resource managers for establishment of compatible resource development standards, comprehensive monitoring, and data collection and interpretation."

In carrying out these duties, the Commission is also charged "'encourage economic development and use of the basin's resources to their fullest extent without compromising the present high quality of the Flathead Basin's aquatic environment."

Finally, the establishing legislation requires the Commission to report to the Governor and the Legislature on its compliance with the mandate and continuing information in "land use and land development trends in the Flathead Basin. It is our sincere hope that, after reading this biennial report, you will find that the Flathead Basin Commission has properly carried out its mandate and that it is vital for the State of Montana and the Flathead Basin for us to continue to function as an entity of state government and continue to build upon this unique partnership.

The Flathead Basin Commission consists of representatives of 16 federal, state, local, tribal and British Columbia entities as well as six citizen members appointed by the Governor. Like all entities of government, we are certainly aware of the public demand to contain expenditures and increase efficiency.

To that end, the Commission budget, funded by the state, has been reduced to one staff member and a small office in Kalispell. Further reduction would result in the demise of the Commission. Without a continued commitment of funds from the state, other entities would have no incentive to commit their equally shrinking resources to basin-wide issues. In fact, the British Columbia liaison has informed us that the B.C. government would not be involved unless the Commission spoke on behalf of the Governor's office.

As you read the report you will find that there is increasing public support for protecting water quality and increasing public demand for information, education, and involvement. It is our opinion that no governmental body can do that better than the partnership known as the Flathead Basin Commission.

Sincerely,

Larry D Wilson

Larry Wilson, Chair
Flathead Basin Commission

THE FLATHEAD BASIN

The Flathead Basin encompasses 8,587 square miles in northwestern Montana and southeastern British Columbia. The long, north-south axis stretches 175 miles, while the maximum width is 88 miles.

Included in the drainage are virtually all of Flathead and Lake counties and the Flathead Indian Reservation; the portion of Glacier National Park west of the continental divide; parts of three wilderness areas; millions of acres of forest land under federal, state, provincial, tribal, and corporate management; and thousands of acres of private property.

The Flathead River system is the largest tributary to the Clark Fork River, which is tributary to the Columbia River. The three forks of the Flathead River — North, Middle and South — together supply approximately 80 percent of the water carried within the Flathead system. Other rivers in the drainage are the Stillwater, Whitefish, and Swan. The lower Flathead River — that portion below Flathead Lake — empties into the Clark Fork at the town of Paradise at an elevation of 2,500 feet above sea level.

Elevations elsewhere in the basin range from over 10,000 feet in Glacier National Park to 2,893 at Flathead Lake, the drainage system's major catchment. The lake is the largest body of fresh water in the United States west of the Mississippi River with a full pool surface area of 126,000 acres. The basin contains over 500 lakes which range in size from nearly inaccessible alpine lakes of only several surface acres to Flathead and other large bodies of water including Swan, Whitefish, McDonald, Tally, Little Bitterroot, Blaine, and Echo lakes.

The Flathead Basin maintains remarkably diverse communities of plants and animals including over 300 species of aquatic insects, 22 native and introduced species of fish, and a number of Threatened and Endangered species.

For a more detailed discussion of the basin's physical features, refer to "Flathead River Basin Environmental Impact Study Final Report," available at libraries or from the Commission office.

THE FLATHEAD BASIN COMMISSION IN ACTION

Through its regularly scheduled meetings, the Flathead Basin Commission strives to provide a forum for the discussion of important issues relating to the monitoring and protection of water quality in the basin. At the same time it works to facilitate public awareness of such issues and encourages the public's direct participation at every level.

During the biennium the Commission conducted 12 public meetings throughout the basin, including sessions in Pablo, Polson, Bigfork, Kalispell and Whitefish.

Montana Goveoor Marc Racicot makes a point about cooperatioo between the State aod the Commissioo to lormer Chair Gil Lusk.

In addition to dealing with a variety of ongoing business, the Commission has addressed a number of significant issues through the presentation of panels of experts and nationally recognized speakers.

Among special presentations made at regular Commission meetings during the biennium were:

• A seven member panel discussion of groundwater topics, featuring presentations by technical representatives of federal, state, county agencies and the private sector

• Briefing by Grizzly Bear Recovery Coordinator Chris Servheen of the U.S. Fish and Wildlife Service on the impact of human activity and development on wildlife corridors

• A six member panel presentation on lake management programs, featuring Dr. Eugene Welch, President of the North American Lake Management Society; Frank Lapensee, Chief of the U.S. EPA Clean Lakes Program; and Ruth Watkins, Pend Oreille Director of the Clark Fork-Pend Oreille Coalition

• Briefing by Montana Governor Marc Racicot, who stated his support of the Commission and its work and commented that the Governor's Office wants to be a good partner of the Commission

• Briefings by representatives of the Confederated Salish and Kootenai Natural Resources Department and tour of the department's facilities

• Several briefings on the Columbia River System Operation Review by Commission members and visiting experts

• Formal report on the state of Flathead Lake by University of Montana Biological Station Director Dr. Jack Stanford

• Presentation by Bill Bourgeois, representative of the British Columbia Commission on Resources and Environment land use management planning process

• Report on Total Maximum Daily Loads, the Federal Clean Water Act method of creating anti-pollution strategies, by Bruce Zander of the U.S. Environmental Protection Agency

• Briefing by Paul Cooke of the U.S. Army Corps of Engineers on the agency's Flood Plain Warning System on the Flathead River

• Presentation on economic sustainability in the Flathead Basin by local and regional authorities, highlighting the compatibility of water quality and economic activity objectives

• Briefing by U.S. Forest Service officials on forest fire rehabilitation efforts and salvage operations

• Several briefings on the Governor's Bull Trout Round Table and the Commission's role in that process.

A DYNAMIC COMMISSION

During the biennium, the Commission saw a change of leadership, the appointment of a new Executive Director, the departure of a number of members, and the appointment of new members by Governor Racicot and various participating agencies.

Gil Lusk, then Superintendent of Glacier National Park, completed a two year term as Chair and was succeeded by Vice Chair Larry Wilson, a citizen member. Elna Darrow, also a citizen member, was elected to succeed Wilson as Vice Chair.

Glenn Marx, Natural Resources advisor to Governor Racicot, was selected by the governor to replace Rick Bartos as Executive Director. Marx had served in the same position for two years under Governor Stan Stephens.

Members who ended service on the Commission included Lusk, National Park Service; George Eskridge, Bonneville Power Administration; John Lozeau, Confederated Salish and Kootenai Tribes; Jeff Janke, Montana Department of State Lands; and citizen members Charles Abell, JoAnn Speelman and Jean Cumming.

Jerry Sorensen, Lake County representative, resigned and was replaced by Paddy Trusler, Lake County Sanitarian, who was succeeded by Forrest Sanderson, Lake County Land Services. Sorensen was reappointed as a citizen member. Other new members include Rhonda Swaney, CSKT; Gail Kuntz, BPA; Dave Mihalic, Glacier National Park; Bill O'Brien, MDSL; and Marilyn Wood and Colleen Allison, citizen members.

The Commission is administratively supported in Kalispell by one full time staff person, Mark Holston, who is a member of the Governor's staff and functions as Public Information Officer. Other administrative support is provided by Governor's Office staff in Helena and occasional volunteer assistance.

Five Year Goals, Committee Reorganization

At a July, 1994 strategic planning retreat, the Commission identified objectives to be accomplished during the next five years that will require a number of distinct roles for the organization, including coordination, monitoring, participating, educating, and development and initiation.

Among the top goals were comprehensive watershed planning, water quality monitoring, and the creation of a scientific round table to study key ecosystem management questions.

To accomplish these goals, the Commission formalized two ad-hoc committees, Watershed Planning and Scientific Round Table, and created a sub-committee of the Education, Information and Recognition committee to deal with the issue of economic development compatible with maintaining water quality.

Commission Executive Director Glenn Marx, right, and other Commission members take in a presentation at one of six bi-monthly meetings conducted annually at sites throughout the basin.

Given that its objectives had been met, the Hazardous Materials Committee was disbanded. The other standing committees are Executive, Monitoring, and Bilateral Cooperation and Planning.

EDUCATION, INFORMATION AND RECOGNITION

A strong public education effort is essential to maximize the Commission's effectiveness in accomplishing its legislative mandate. In recognition of the importance of public understanding of water quality issues and the value of broad based citizen involvement, the Commission works to foster knowledge and encourage participation in problem-solving initiatives.

Public Education

The Commission's sole staff member is designated a Public Information Officer (PIO). In addition to working directly with the Chair and Executive Committee to carry out Commission policy, the PIO designs and implements a variety of information initiatives designed to address objectives defined by the Education, Information and Recognition Committee.

Among those routine and ongoing efforts involving Commission membership and staff are:

- Working with local, regional, and national media to enhance the public's knowledge of the Commission and its work
- Designing and producing a variety of information tools, including publications, videos, slide programs, brochures, and newsletters
- Representing the Commission's interests in public forums, including the presentation of approved testimony
- Serving in a liaison role with local and state organizations of direct interest to the Commission and serving as a committee member with organizations whose goals are compatible to those of the Commission
- Providing educational outreach services to schools, civic groups and others interested in water quality issues and the Commission's role in the Flathead Basin
- Assisting members of the public, agencies, and public interest organizations in accessing information available through the Commission's library and data base.


BASIN WATCH

Volunteer workshop date set

BASIN WATCH, a newsletter begun for the Volunteer Monitoring Program, will feature additional information on water quality issues and an expanded public distribution during the current biennium as part of the Commission's effort to carry its message to a broader spectrum of the basin's residents.

COMMISSION IN ACTION:

▶ Public Information Officer presented the paper "A Non- Regulatory Approach to Protecting Water Quality" to the annual Advancement of Science, University of Montana, June, 1993.

▶ Created and regularly published Basin Watch, a newsletter designed for participants in the Volunteer Monitoring Program. Basin Watch will be expanded in 1995 to include other Commission-related information and will be distributed to a wider readership as the official newsletter of the Flathead Basin Commission.

▶ Presentations made during the biennium included: primary through high school classes, grange organizations, Leadership Flathead, Flathead County GOP Women, Earth Day, Family Forestry Expo, Flathead Lakers, church groups, and Japanese university exchange students.

▶ Represented the Commission through regular participation as a member of: Montana Water Course Advisory Committee, Environmental Educators CORE Group, Kalispell Area Chamber of Commerce Natural Resources Committee, Flathead Groundwater Coordinating Committee, Flathead River Partnership, Cooperative Planning Coalition, and Flathead County Local Emergency Planning Committee.

Summary:

The success of the Commission's public information initiative is central to its image in the basin and critical to the success of its programs. Efforts such as expanding newsletter distribution will help the Commission maintain and enhance its public profile in addition to providing the area residents with essential information that will allow them to do a better job of protecting water quality.

Issues Monitoring

Columbia River System Operation Review

The Flathead Basin Commission has played a leadership role in several ongoing processes of regional and national importance.

The Columbia River System Operation Review is a case in point. The Commission has maintained a high profile in the process, contributing directly to it in a number of productive ways.

A multi-year process by the U.S. Army Corps of Engineers, Bonneville Power Administration, and the Bureau of Reclamation, the SOR's goals include the development of a coordinated strategy for managing the multiple uses of the Columbia River system. In late 1994, a draft EIS was released for public review.

The Commission's role in the SOR has been highlighted by formal testimony presented periodically during the process. The Commission's voice in the matter emerged as a strong advocate for Flathead Basin water quality and fishery concerns and the necessity of a full opportunity for public participation in the process. In September 1994, SOR was asked by the Commission to reconsider its emphasis on salmon recovery and return to the review process to one that is driven by system-wide issues rather than a single issue.

Northwest Power Planning Council

The Northwest Power Planning Council (NPPC) was established by the U.S. Congress and governors and legislatures of Montana, Idaho, Washington and Oregon to develop a regional approach to providing hydro-electric energy while protecting the Columbia River Basin's fish and wildlife.

Similar to the direction taken by the Columbia River System Operation Review, NPPC has been amending its fish and wildlife program to take into account the listing of salmon as an Endangered Species. In recent months the Commission has taken NPPC to task for ignoring Montana's needs and proceeding, at great risk to water quality in Montana, to send Montana's water downstream to help solve Idaho's problems.

Kerr Dam Mitigation Issue

The matter of the Federal Energy Regulatory Commission's decision to prepare an Environmental Impact Statement on the environmental effects of the operation of the Kerr Hydroelectric Project is another issue that poses unique challenges for the Commission.

Since 1990, the Commission has expressed its concern that the public had not been given an adequate opportunity to participate in the development of the Kerr Project Mitigation and Management Plan. Among the Commission's concerns were the lack of coordination between operations and mitigation efforts at Hungry Horse Dam and Kerr Dam; failure to recognize the potential for cumulative environmental impacts on Flathead Lake and the Flathead ecosystem; the lack of operational mitigation on the Flathead River below Kerr Dam; and the long term impact of the water quality of Flathead Lake and continued erosion along the shores of the lake.

In announcing its decision to conduct an EIS, FERC proposed that the Commission play a consultative role with Montana Power Company and others to: identify and develop nutrient control strategies for both point and nonpoint sources contributing to the enrichment of Flathead Lake; to identify regional causes of degradation of the lake that could impact the same resources affected by Kerr Dam operations; and to identify mitigation opportunities to lessen the cumulative impacts on those resources.

Commission Vice Chair Elna Darrow presents testimony at a public hearing. The Commission routinely monitors issues relating to water quality and provides comment when appropriate.

The protection of Flathead Lake's water quality remains a primary focus of the Commission, which cooperates with the Northwest Power Planning Council, the Columbia River System Operation Review and other processes to bring a higher level of effectiveness to management of this significant natural, economic, cultural, and aesthetic resource.

The Commission has responded that it will cooperate with the process. As of the writing of this report, the FERC EIS process had not further defined a role for the Commission and neither has the Commission sought a role.

Commission in Action:

▸ The Commission, through the Education, Information and Recognition Committee and Executive Committee, monitored the progress of both the SOR and FERC issues and developed positions on both, which were articulated in formal testimony presented at hearings conducted in the basin.

▸ The Commission has not taken a position on any of the alternatives identified in the FERC draft Environmental Assessment, but has expressed its support of the EIS process and has renewed its request that the public be given every opportunity for access to the process.

Confederated Tribes Vice Chair Rhonda Swaney, a presenter at the Crown of the Continent Ecoregion Workshop, makes a point about the historical presence and involvement of native peoples in the basin.

Crown of the Continent Ecoregion Workshop

Through two days of presentations, one-on-one discussions, and field trips organized under the banner of the Crown of the Continent Ecoregion Workshop, representatives of several major national foundations had a unique opportunity to learn of the problems confronting the basin and hear about solutions that are being proposed to deal with those problems.

Presenters included representatives from industry, public interest groups, environmental organizations, educational institutions, government agencies, and other organizations that have influence in the Flathead Basin. Participating foundations included The Northwest Area Foundation, The Rockefeller Brothers Fund, The Hewlett Foundation, The Kendall Foundation, and The Consultative Group on Biodiversity.

The Commission's goal was to introduce the foundation community to the major players involved with the basin's most compelling issues and to assist in building a bridge between local groups and foundations that can be further developed in the future.

The workshop was made possible through the financial contribution of an anonymous foundation.

Commission in Action:

▸ The Commission produced and distributed a summary of proceedings of the workshop, including the complete text of most of the presentations and a roster of attendees and presenters to encourage future communication among the participants.

Summary:

The workshop provided the community with a well organized forum through which often contradictory opinions on controversial issues could be expressed in an atmosphere where mutual respect and consensus seeking were given top priority. Participating foundations benefited from insights into the economic, social and environmental problems of the Flathead Basin while local participants were able to experience a wide range of thought on matters of the utmost importance in the basin.

Northwest Area Foundation President Terry Saario and Commission Chair Larry Wilson discuss public policy issues at the Ecoregion Workshop.

Flathead River Partnership

The Flathead River Partnership, an effort initiated during the previous biennium by the Commission and a number of other interested agencies, has evolved to become a largely publicly-driven process to encourage better use of the mainstem of the upper Flathead River.

The Partnership, with Commission support and participation, conducted a number of public scoping meetings during 1994 to obtain citizen input on issues effecting the river. The Partnership also conducted a week-long survey during August 1994 of activity on the river and the attitudes and concerns of river users at numerous sites along the 42 mile corridor.

With continued technical assistance from the Rivers, Trails and Conservation Assistance Program of the National Park Service, the Partnership is working with the public-at-large and representatives of organizations to further define the top three issues identified through the earlier public scoping process. Facilitated groups will work during a six month period in early 1995 to study the issues and make appropriate findings and recommendations available to a variety of agencies and the public.

Commission in Action:

- Commission staff has provided administrative and organizational assistance to facilitate a regular flow of communications and regular group sessions.
- Commission staff wrote and produced slide program for initial Partnership public information effort and has written and produced publicly-distributed brochure on the effort.

Summary:

The Flathead River Partnership is well positioned to become an effective advocate for better use of the mainstem of the upper Flathead River. Through the participation and support of the Commission and other agencies, the Partnership has become a process through which members of the public can have a meaningful role in helping determine the future of this major basin resource.

Awards and Recognition

The Commission realizes that many individuals and organizations are involved in ongoing efforts to protect and improve water quality in the Flathead Basin. Through its recognition of such activities, the Commission hopes to encourage others to commit to a similar course of action

The creation of the Stewardship Award is a good example. The Commission is able to recognize significant individual contributions to the effort. The award is given to non-agency members of the community who have exhibited extraordinary persistence, skill and success in accomplishing their efforts to protect water quality.

Commission in Action:

- The Commission is creating a range of other awards and recognition strategies which will acknowledge the wide range of efforts that individuals, organizations, and businesses are making toward improving water quality in the basin.
- The Commission is designing and organizing a series of science contests for area students which will encourage schools to focus on the Flathead's aquatic resources for study purposes. The competitions are being designed for different age levels and will include cash awards for winners.

Don Peterson, a participant in the Flathead River Partnership process and a property owner on the main stem of the river near Kalispell, surveys an example of serious bank erosion. The Partnership uses education as a tool to encourage better public attitudes about the river stewardship.

BILATERAL COOPERATION AND PLANNING

Flathead and Lake counties continue to rank among the fastest growing areas in the state. In addition to a steady influx of new residents, the region has shown dramatic growth in terms of retail business and tourism/ recreation-related development. Meanwhile, a land use planning process in British Columbia has brought new importance to the Commission's goal of coordinating management policies with B.C. for the shared headwaters of the North Fork of the Flathead River.

Land use trends in the Flathead Basin

Kalispell, the basin's major population center, enhanced its viability as a regional trade center through the arrival of such major retailers as Walmart, Shopko, Costco and Ernst.

The Big Mountain Ski Resort, meanwhile, is expanding its facilities with the target of adding some 1,600 living units to the complex. Golf, a boom industry in both the Flathead and Mission valleys, has seen significant growth with the expansion of several existing courses and planning for new courses.

The beauty associated with the basin's plentiful aquatic resources and the many recreational opportunities they afford are directly linked to local perceptions about "quality of life" and are frequently cited as a primary reason why people choose to live in the Flathead.

Plum Creek Timber, Inc., the largest private land owner in the basin, has hired a professional land use planner and is looking at intermediate and long range strategies for appropriate uses of some lands not well suited for long term timber production.

Population Trends

The population of Lake County in 1992, the last year for which there was accurate information, was 22,051. That represents a 2.4 percent annual increase as Lake County adds about 550 new residents annually. The estimated population for 1994 is 23,110.

Flathead County posted a population of 62,857 in 1992, which reflects an annual growth rate of 2.8 percent since 1990. Currently, Flathead County is adding approximately 1,600 new residents a year. The estimated population for 1994 is 66,000.

During the same time, Montana's population growth, on average, has been about one percent. Nationally, population growth is slightly less than one percent.

Land Division, Septic Systems and Housing Trends

Land division and septic permits are key indicators of growth.

In Lake County, 232 new lots were created in 1992 and 154 in 1993. Septic permits totaled 218 in 1992 and 266 in 1993.

In Flathead County, new lots created included 472 in 1992, 358 in 1993, and 447 in 1994. Septic permits totaled 1,232 in 1993 and an estimated 1012 in 1994.

Planning Efforts

The Commission has long been an advocate of comprehensive basin-wide land use planning. It recognizes the relationship between population growth, accompanying human activity, and the demonstrated effect on water quality.

Through public forums, workshops, publications, resolutions, recommendations to the governor, public education initiatives, and working directly with the public on localized land use issues, the Commission has taken a leadership role in making an effective land use strategy central to its mandate to protect water quality in the basin.

Lake County

Residents of Lake County, working with the county's planning department staff and a consultant, have moved aggressively in recent years to formalize land use planning in a number of environmentally sensitive areas.

Seven new zoning districts have been created as a follow-up to the county's master plan, including four districts on Flathead Lake and two on Swan Lake. Polson, the county's major urban center and largest city on Flathead Lake, completed an update to the plan and zoning regulations which includes the surrounding area as well.

Flathead County

An ambitious three year process to create an update to the county's land use master plan succeeded in winning Planning Board and County Commission approval in late 1994.

The community-driven planning effort attracted national attention due to its bottom up, mostly privately financed character and its emphasis with providing the public with innovative alternatives to traditional zoning. The plan also provided techniques for protecting the character of local neighborhoods and such significant assets as water quality and scenery while accommodating one of Montana's highest rates of growth.

The Cooperative Planning Coalition, a broad alliance of business, environmental, governmental and community-based public interest groups, assumed responsibility for raising over half a million dollars to fund the process, hired a land use consulting firm, and facilitated an extensive public involvement phase.

Through nearly a year of CPC-directed neighborhood-level meetings, hundreds of county residents provided essential input at regularly scheduled monthly meetings in a dozen communities throughout the county. A survey, mailed to all county residents, identified the protection of water quality — the first choice of 95 percent of survey respondents — as the most important goal the plan update should take into account.

As a basis for future planning guidelines, teams of local experts produced 20 "White Papers" which address subjects ranging from affordable housing and agriculture to commercial and industrial concerns and cultural and historical resources.

Independent of the CPC Master Plan update process, Bigfork and the Canyon area carried out and finalized citizen-driven planning processes for their communities. Lakeside also completed a neighborhood level planning process for its Flathead Lake community.

U.S. Highway 93 EIS

The Flathead Basin's major vehicular transportation corridor was the focus of two EIS processes during the biennium. Proposed highway reconstruction projects will improve portions of U.S. 93 between Evaro and Polson in Missoula and Lake counties and between Somers and Whitefish in Flathead County.

The projects are being designed to reduce congestion, improve safety and enhance scenic values, among other concerns. Water quality concerns include impacts on wetlands, streams, and other nearby bodies of water.

The EIS process included extensive public participation and the involvement of a wide variety of governmental entities. Consideration of water quality and other environmental issues was among an array of criteria taken into account in the formulation of the preferred alternative.

The Somers to Whitefish study produced four alternatives, including a preferred alternative and detailed proposals for a Kalispell bypass and six alternate downtown routes in Whitefish.

An EIS process for the Evaro to Polson segment was also underway.

Rapid and haphazard development is quickly changing the face of the basin's landscape. The Commission has stated policy of encouraging responsible land use planning techniques to minimize the effects of population growth and development on water quality.

British Columbia Land Use Planning

The B.C. government established Commission on Resources and Environment (CORE) in 1992 to develop a land use strategy for the province.

The East Kootenay region was identified as one of several geographical areas in the province to undergo the CORE process. A portion of the southeastern corner of the East Kootenay contains the headwaters of the North Fork of the Flathead River, an area in which the residents of the U.S. portion of the Flathead Basin have taken great interest.

The creation of the Flathead Basin Commission was directly linked to concerns about the environmental impact of proposed development and resource extraction in the B.C. portion of the Flathead drainage. Since the Commission came into existence in 1983, working with the B.C. government to coordinate a management strategy for the North Fork of the Flathead has been one of the Commission's priorities.

The CORE process culminated after over a year of intensive study and public involvement. Among the recommendations being forwarded to the provincial cabinet by the Commissioner of CORE are Special Management designations for the upper Flathead Basin and the North Fork of the Flathead River corridor and a proposed Protected designation for the adjoining Akamina-Kishinena area.

The Flathead Basin Commission hopes to continue working with representatives of the B.C. public and government when detailed planning is carried out at the local level.

The North Fork of the Flathead River is the least developed of major watersheds shared by the U.S. and Canada. The Commission has worked with citizen and government entities on both sides of the border to encourage a cooperative approach to managing this important headwater basin

Commission in Action:

- The Commission was an early supporter of the Cooperative Planning Coalition process and an original member of the organization.
- The Commission supported the Flathead County master plan update process through participation of the Commission staff member as a representative on the CPC board, as chair of the communications committee/public education effort, and as a contributor to the White Paper on Ecosystem Management.
- The Commission further supported the planning process through ongoing monitoring of the effort at its regular meetings, public comment by the Commission chair, and testimony in support of the proposed plan update to the Flathead County Planning Board.
- The Commission, representing the Governor's Office, observed, participated in, and monitored the BC CORE process, providing verbal comments during CORE sessions and written comments from the Commission chair to the chair of CORE.
- Governor Racicot wrote B.C. Premier Mike Harcourt suggesting the creation of an international round table to assist in guiding management of the shared resource of the headwaters of the North Fork of the Flathead River.
- As a follow-up to Governor Racicot's initiative, a delegation of Commission representatives met with B.C. Land Use Coordination Assistant Deputy Minister Derek Thompson to further explore the concept of close coordination and cooperation in managing the North Fork. The Commission is hopeful that a Flathead River International Round Table will be formalized in 1995.

Summary:

The Commission has seen positive developments in its effort to attain a higher level of cooperation with British Columbia in coordinating management of the North Fork of the Flathead River. Through the active involvement of Governor Racicot and his B.C. counterpart, the prospects for achieving the Commission's North Fork objectives are significantly enhanced.
The principles of ecosystem management have evolved rapidly in recent years.Today, land managers are likely confronted by many questions when attempting to implement such principles on a site-specific basis.

SCIENTIFIC ROUND TABLE

In recognition of a number of unique issues that land managers in the Flathead drainage must consider, the Flathead Basin Commission has created a process through which the various scientific aspects of those issues can be examined.

The process, coined the Flathead Basin Commission Scientific Round Table, will involve the participation of leading academics from Montana State University, the University of Montana, the University of Idaho, and scientists from the public sector and various management and regulatory agencies active in the basin.

The Scientific Round Table has identified a number of management questions related to terrestrial and aquatic ecosystem management issues and human use and benefit issues. Through the efforts of the Scientific Round Table, which is scheduled to continue through most of the 1995-96 biennium, the Commission will be able to assist land managers in implementing a process that integrates ecosystem management principles into basin-wide planning.

Commission members receive a brieling from Plum Creek Timber Company foresters on how that private land owner manages its property to protect water quality. The Scientific Round Table process will provide both private and public resources managers with new ways of addressing complex management questions.

HAZARDOUS MATERIALS

The threat to public safety and the maintenance of high levels of water quality posed by the proximity of heavily used transportation corridors to primary basin waterways and the routine shipment of hazardous materials through the watershed has long been recognized by the Commission. The creation of a committee specifically charged to address the issue and the formalization of an action plan to accomplish its goals underscored the Commission's commitment to responsibly address the question of hazardous materials in the basin

The Hazardous Materials Committee had been successful in addressing the issue of hazardous materials spills and related water quality concerns to a new level of public and agency interest within the basin and at the state level. The committee encouraged and worked with disaster and emergency services agencies of Flathead and Lake counties and the Confederated Salish and Kootenai Tribes to insure the highest level of cooperation and preparedness.

Commission in Action:

► The Commission was instrumental in the formation of the state-wide Coordination Council for the Transportation of Hazardous Wastes and Materials and participated through the involvement of the Hazardous Materials Committee chair.

► The Commission addressed the Environmental Quality Council in an effort to have the transportation of hazardous substances included in an interim study done by the Hazardous Waste Management Working Group pursuant to SJR 34.

► The Commission has continued to monitor the progress of work being done by the U.S. EPA at several hazardous materials clean-up sites in Flathead County and settling ponds at the Columbia Falls Aluminum Company.

Summary:

Major strides have been made within the basin to prepare for the eventuality of hazardous materials spills. Disaster and Emergency Services agencies of both counties and the Confederated Tribes have acquired and deployed clean-up materials and have enhanced training and coordination. Recent incidents have demonstrated that response time and effectiveness on the part of responsible agencies have improved. The Hazardous Materials Committee can be reactivated if the Commission recognizes a need for further work on these or other related issues.

WATERSHED PLANNING

The concept of watershed planning is one the Commission has been moving toward for some time. Through such an approach, the numerous needs of the basin can be addressed in a comprehensive manner, stressing public participation and agency cooperation.

The initial phase of the Commission's watershed management strategy involves two closely related processes.

One is already underway thanks to the receipt of a $10,000 grant from the U.S. EPA. The Commission, in cooperation with the Confederated Salish and Kootenai Tribes, the Montana Department of Health and Environmental Sciences, and the Montana Department of Natural Resources and Conservation, has selected a part time Watershed Planning Coordinator.

The coordinator has initiated a 16 month process in early 1995 with the public and other involved entities in the basin to define protection targets for key nutrients, identified by the U.S. EPA as Total Maximum Daily Loads. The result will be the preparation of a joint State/Tribal TMDL strategy.

The broader purpose of the Commission's Watershed Management Plan is to facilitate and encourage the integration of science, management, and policy to enhance water management and to protect water quality within Flathead Lake and the watershed. That will be made possible through anticipated Legislative approval of a $100,000 proposal to the Department of Natural Resources and Conservation Water Development and Renewable Resource Development Grant Program. To date, the proposal has been given a high ranking. Its eventual approval will allow the Commission to proceed with its full scale watershed management initiative.

Commission in Action:

► Received the financial assistance of the Flathead Lakers, who contributed $1,000 to fund the writing of and application to the Water Development and Renewable Resources Grant Program and worked with the Tribes and cooperating state agencies to produce a final grant application agreeable to all participants.

► Helped create a Request For Qualifications to solicit candidates for the TMDL Coordinator position.

Summary:

Watershed management is the best way for the Commission to achieve its goal of protecting the basin's aquatic resources. Receipt of the Development and Renewable Resources Grant, which requires Legislative approval, will allow the Commission to begin work on this important process.

A comprehensive approach to watershed planning is the most effective way to insure that upstream activities will have the least possible effect on Flathead Lake.

MONITORING

The coordination of water quality monitoring in the Flathead drainage is central to the Commission's mandate. In writing the Commission's establishing legislation in 1983, the Montana Legislature emphasized that the monitoring plan "must involve a cooperative strategy among all land and water management agencies within the Flathead Basin."

Monitoring Master Plan

The Commission has served as the coordinator of a basin-wide monitoring effort since the initial Monitoring Master Plan was drafted in 1985. With the updating and implementation of a modified plan in 1993, the Commission is now able to achieve an even higher level of agency participation and cooperation, resulting in a more broadly-based, scientifically valid monitoring effort.

Through the efforts of an inter-agency Monitoring Technical Committee, the objectives of the Monitoring Master Plan were modified to include:

Objective A: Monitoring the water quality, quantity, and aquatic life of Flathead Lake and its major tributaries.

Objective B: Monitoring the water quality, quantity and aquatic life from representative catchments of the upper basin.

Objective C: Monitoring bull trout populations and habitat in the basin.

To accomplish its goals, the updated plan includes the designation of 12 sites to address Objective A, 34 sites for Objective B, and 19 sites for Objective C. Monitoring activities include a wide variety of chemical and limnological parameters, discharge, temperature, elevation, fish population and habitat, and other relevant data.

Activities outlined by the Monitoring Master Plan are conducted and paid for by a variety of agencies through the coordination of the Commission.

Commission in Action:

- The Commission voted to accept the recommendations of the Technical Advisory Committee and adopt the revised Monitoring Master Plan.

- The Commission has begun an effort to secure additional funding needed to fully implement the Monitoring Master Plan. The Commission accepted funds from Friends of the Wild Swan, a public interest group, to facilitate monitoring at two Lion Creek sites in the Swan River drainage that would have gone unmonitored due to lack of agency funds. The sites are in an undisturbed watershed where the establishment of baseline data is especially important.

- The Commission formalized the role of the Public Information Officer as coordinator of the monitoring program

Summary:

The modified Monitoring Master Plan gives the Commission the kind of detailed comprehensive information it needs to monitor conditions and trends of aquatic ecosystems in the Flathead Basin. To date, the plan has encouraged a high level of inter-agency cooperation. Additional sources of funding will have to be secured to allow the plan to achieve its full potential..

Water quality monitoring includes a wide variety of professional and volunteer activities that range from complex chemical analysis to simple, routine observations. Collectively, the procedures help the Commission keep track of short and long term water quality trends in the basin.

Fisheries Mitigation

Efforts to address the effect of Hungry Horse Dam on the downstream fishery have seen a major advance during the recent biennium.

The thermal effects of discharges from the dam have been addressed through the design of a selective withdrawal system that will allow water to be taken from three levels in Hungry Horse Reservoir, thereby matching the thermal conditions of the water immediately downstream in the South Fork of the Flathead with reservoir water that is discharged into it. The improvement, which has received funding and is in the initial stages of construction, should have a dramatic positive effect on the fishery, aquatic insect population and other attributes of the downstream portion of the Flathead River.

Fisheries biologists say the implementation of the selective withdrawal system should increase trout growth in the affected portion of the South Fork by a factor of 10, and that the potential for increase in trout population in the mainstem of the Flathead River could increase by a factor of two to five.

In a complementary project for the fishery above Hungry Horse Dam, funds have been received from the Bureau of Reclamation to correct fish passage problems created by road construction around Hungry Horse Reservoir. As a participant in a cooperative agreement with the Bureau of Reclamation, the Commission is coordinating the receipt and dispersal of $125,000 in funds from 1994 to 1997. The initial $40,000 received through the agreement has been dispersed to pay for the work Flathead National Forest-supervised contractors have carried out on the project to date.

The pace of rural development and the accompanying use of individual septic systems pose problems for water quality. The Commission urges the use of state-of-the-art community waste water treatment systems when feasible.

Commission in Action:

- The Commission worked with the Montana Congressional delegation to secure funding required for the Hungry Horse Dam selective withdrawal project.
- The Commission carried out its coordinator's role to expedite the transfer of funds needed to begin work on the fish passage project.

Waste Water Treatment

The performance of municipal waste water treatment systems is not the problem it once was for water quality in the Flathead Basin.

Currently, all municipal or community systems in operation in Flathead County are considered by the MDHES to be state-of-the-art tertiary systems. Kalispell's extensively upgraded facility is now capable of meeting or exceeding all discharge limits.

Neighboring Evergreen, a bedroom community of approximately 8,000 residents, occupies land adjacent to the Flathead, Whitefish and Stillwater rivers in a region of the Flathead Valley known for its high water table. The area is in the final stages of having its new waste water collection system integrated into the Kalispell municipal system. Completion of that project will dramatically reduce the source of sewage contamination into the river network-connected groundwater system in the Evergreen area.

Summary:

A priority of the Flathead County land use Master Plan update has been to encourage growth in areas served by community waste water treatment systems. Given the rate of growth in the county, existing systems, as capable as they are at this time, could face difficulties in meeting water quality standards if their load capacity increases significantly. The situation will require close monitoring, cooperation, public involvement, and planning to insure that the high standards of today can be met in the future.

Groundwater Coordinating Committee

Organized on an informal basis, an ad-hoc committee comprised of scientists and other technical experts from the private sector and a number of county, state and federal agencies has met for two years to address local ground water issues. The goal of the effort has been to coordinate the collection and storage of information and to encourage wise use of public resources in future research of groundwater resources in the county and adjoining areas.

Desiring closer coordination with the Flathead Basin Commission, and in recognition of its

complementary role, the committee asked for Commission recognition of its mission and formalized working relationship.

Commission in Action:

► The Commission, acknowledging the importance of the committee's work, voted unanimously to have the FGCC serve as a technical advisory committee to the Monitoring Committee. A provision requires that other organizations, including the U.S. Geological Survey, Montana Bureau of Mines and Geology, and the geology departments at the University of Montana, Montana State University and Montana Tech be invited to participate on the FGCC.

Volunteer Monitoring Program

In the summer of 1992, the Commission initiated the first monitoring program for citizen volunteers in Montana. Since then the program has grown through the number of volunteers involved, lakes monitored, parameters tested, and funds received to administer and upgrade the program.

The program serves a dual purpose, cultivating the public's interest in positive stewardship values while establishing baseline information that will be of use to a number of agencies and institutions, including the U.S. EPA, Montana Department of Health and Environmental Sciences and the University of Montana Biological Station.

Currently, the program has 40 active participants who conduct monitoring activities at 41 sites on 26 lakes in Flathead and Lake counties. The volunteers return their field data to the Commission office where it is added to a computer data base. Once a year, in mid summer, the program's Volunteer Coordinator visits each site and works with the volunteers to sample for additional parameters. Field chemical data are analyzed by the University of Montana Biological Station.

Summaries of the data are regularly shared with the volunteers, interested agencies, the Commission, and the media.

Working with the Biological Station and the MDHES Water Quality Bureau, the Commission organizes and conducts two annual workshops for volunteers, emphasizing training and enhancing the overall knowledge of the participants.

The Commission has received funding from the U.S. EPA Clean Lakes Program, which offsets expenses incurred by: the employment of a summer Volunteer Coordinator, publication of the newsletter Basin Watch; purchase of equipment and supplies needed for the program, conducting workshops and training sessions, maintaining records and a data base, preparing reports required by the EPA grant, and allowing for participation at conferences relating to volunteer monitoring issues.

Commission in Action:

► Has provided assistance in helping MDFWP establish a complementary program in watersheds adjoining the Flathead Basin.

► Has served on an advisory committee to oversee the establishment of Project Free Flow, a complementary river and stream monitoring program for basin public school students.

► Created the newsletter Basin Watch, which will be expanded in editorial scope and distribution to serve as a regularly published newsletter of the Commission.

Summary:

The Volunteer Monitoring Program has succeeded in attracting a level of participation that is broadly based and enthusiastic. Great and small lakes are being monitored throughout the basin, from the Flathead Indian Reservation to the headwaters of the Stillwater and Whitefish rivers. The program has also encouraged a higher level of cooperation among such interested entities as the Biological Station and the MDHES Water Quality Bureau. The program's steady growth rate is an indication of the interest of the greater basin community in water quality issues.

A comprehensive report on data collected by the Volunteer Monitoring Program since its inception, currently being prepared for submission to the U.S. Environmental Protection Agency, will be available upon request from the Commission in August, 1995.

Volunteer monitors have become increasingly important to the Commission's overall monitoring effort. Their participation will be expanded to include the monitoring of other parameters and additional water quality research-related tasks.

WATER QUALITY MONITORING STATUS REPORT

Executive Summary

This section of the Biennial Report summarizes current information pertaining to the overall objective of monitoring water quality in the Flathead Basin. The researchers involved in this monitoring process have not attempted to interpret thoroughly all the data in the water quality monitoring database. Rather, they have identified and analyzed key findings. A summary of key conclusions and recommendations is provided on page 34.

Under the guidelines of the Commission's Monitoring Master Plan, researchers regularly collect data to establish baseline water quality conditions, to detect trends in water quality at selected sites, to detect and document sources and causes of water pollution, to measure the integrity of select biological communities by monitoring the habitat and populations of such indicator species as bull trout, and to develop predictive relationships between key hydrological, chemical, physical, and biological variables.

A primary goal of the Flathead Basin Commission is to identify existing or potential water quality problems in the drainage and determine the sources of pollution. A number of agencies and organizations work in cooperation with the Commission to monitor water quality and fisheries.

Background

Why Monitoring Water Quality Is Critical

What do people think of when they picture a land of pristine waters? Do they see themselves walking along cold, clear streams? Canoeing on a sparkling alpine lake? Reeling in a trout from the bank of a slow-moving river?

These images reflect various aspects of relatively pure water. Signs of declining water quality might reflect the opposite of such scenes: murky water in a stream, a lake choked with aquatic plants, or an angler unable to entice a fish to take a lure.

These examples relate to the "big picture" of water quality. However scientists measure water quality using specialized techniques and sensitive indicators. They monitor the amount of various chemical substances dissolved and suspended in water. They also check on such things as the condition of stream bottoms and lake shores, streamflow, water temperature, turbidity, sediments, and the clarity of water.

Since fish live in water, the same variables strongly affect them. Therefore researchers evaluate fish habitat quality by looking at the size and amount of fine materials in streambeds and the emergence success of fry from gravels. They analyze fish populations by measuring the number and size of fish and by counting redds (nests built by spawning fish). They also monitor zooplankton (minute animals eaten by fish) to determine their effect on fish populations.

The Flathead River Basin Environmental Impact Study, conducted from 1979 through 1983, gathered and analyzed data related to various aspects of water quality. The study concluded that waters of the basin were generally very pure, but the study also documented a trend of declining water quality attributable to both human-caused and natural activities.

Only through continuous, coordinated, and properly conducted monitoring will researchers, government agencies, and the public be able to identify sources of pollution and have the scientific information available to help develop effective and responsible means to reduce or eliminate such threats to the basin's enviable high level of water quality.

How the Water Cycle Works

Most water is retained in the Flathead drainage system for only a short period of

time. The highest mountains in the basin may receive 70 inches or more of precipitation annually, whereas valleys typically receive between 15 and 20 inches a year. Once precipitation reaches mountainous terrain, some of it will run off, some will evaporate, some will enter vegetation, and the remainder will percolate through the soil into the groundwater system. Much of the groundwater will eventually emerge as a spring or enter directly into a creek or lake.

Water remains in ponds and lakes for varying amounts of time. In deep lakes, water stratifies during the summer as the upper layer is warmed by the sun and the lower layer remains cool. The denser colder water may remain confined to the lower levels of the lake until late in the season when all lake water is likely to achieve the same temperature and result in a mixing of the previously stratified portions.

Water entering Flathead Lake through its tributary rivers and streams will remain in the lake for about three years before being discharged into the lower Flathead River at Kerr Dam. During that time, most of the suspended sediments will have settled out of the water and onto the lakebed. The result is cleaner water at the discharge point than at the several points where river and stream water is introduced to the lake.

Factors Influencing Basin Water Quality

Freshwater ecology is the study of animals and plants in relation to their aquatic environment. Lakes and streams in the Flathead Basin support many biological species, and this diversity reflects the generally pristine condition of the basin's waters.

While the aquatic species of the basin are notably unique and diverse, individual populations are not normally abundant. The generally sterile nature of the basin's waters and the relatively short growing season limit population growth. Surface waters of the basin contain relatively few essential plant growth nutrients (such as nitrogen and phosphorus). The shortage of such nutrients naturally limits the production of algae and other plants, which in turn limits the populations of fish and other aquatic animals that feed on them.

The naturally low productivity of aquatic plants and animals in the Flathead Basin is a direct result of the basin's high water quality. Increases in productivity may indicate declines in water quality. The addition of even small additions of nutrients may result in the population explosion of aquatic plants and may encourage the proliferation of undesirable fish species.

Both natural and human-caused events can lead to the deterioration of water quality. Virtually all land use activities ultimately affect water quality. The nutrients in atmospheric deposition — pollutants introduced into surface waters through dust, smoke, rain and snow — are also believed to be a significant contributor to water quality problems in the basin. Other key factors that influence water quality include water flow, water temperature, turbidity and sedimentation, water chemistry, and microbiology. For a thorough discussion of these factors, refer to Flathead Basin Commission Biennial Report, 1991-1992.

The Law and Water Quality

A wide variety of federal, state, tribal and local agencies have specific obligations to implement laws and apply regulations designed to protect water quality. A state permit system regulates point sources of pollution, such as discharges from municipal waste water treatment plants, while Best Management Practices (BMPs) are designed to control nonpoint sources of pollution (diffuse sources of pollutants resulting from natural occurrences and human activities over a relatively large area). Most water pollution in the Flathead Basin is attributable to nonpoint sources.

Laws and regulations that affect water quality in the Flathead Basin include:

- the Federal Clean Water Act and the Montana Water Quality Act,
- the Natural Streambed and Land Preservation Act (which regulates development activities taking place in streams and lakeshores),
- the Public Water Supply Law (which regulates logging and other activities with respect to their impact on water quality in watersheds used for public water supplies),

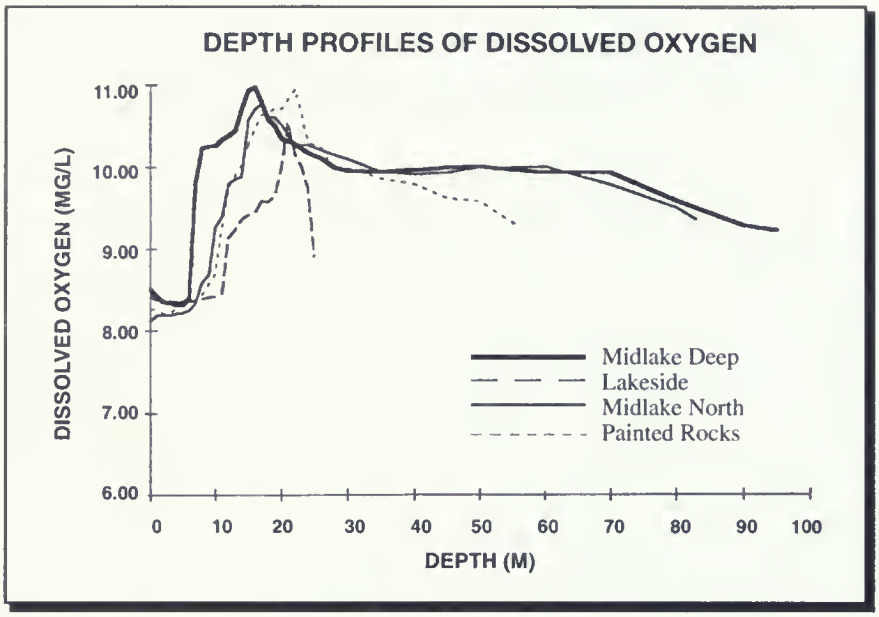


Figure 1. Dissolved oxygen levels at various depths for seven Flathead Lake monitoring sites.

- the Sanitation in Subdivisions Act and the Subdivision and Platting Act (which together provide for state and local review of proposed subdivision),
- the Shoreline Protection Ordinance (which regulates certain structures, dredging, and filling below the high water mark on Flathead Lake and the Flathead River and its major tributaries within the Flathead Indian Reservation), and
- the Streamside Management Zone Law (which regulates timber harvesting activities adjacent to streams).

The Flathead Basin Commission supports agency enforcement of these regulations while encouraging agencies, corporate entities, and the public alike to assist in protecting water quality in the basin through a variety of non-regulatory, voluntary means.

Water Quality in Flathead Lake and Its Tributaries

Findings from a three-year study (1991 through 1993) conducted by the staff at the University of Montana's Biological Station at Yellow Bay were published in the spring of 1994. In this study scientists compared findings at the traditional midlake site with findings at six new sites to determine whether the midlake site was adequate to describe long-term trends in water quality.

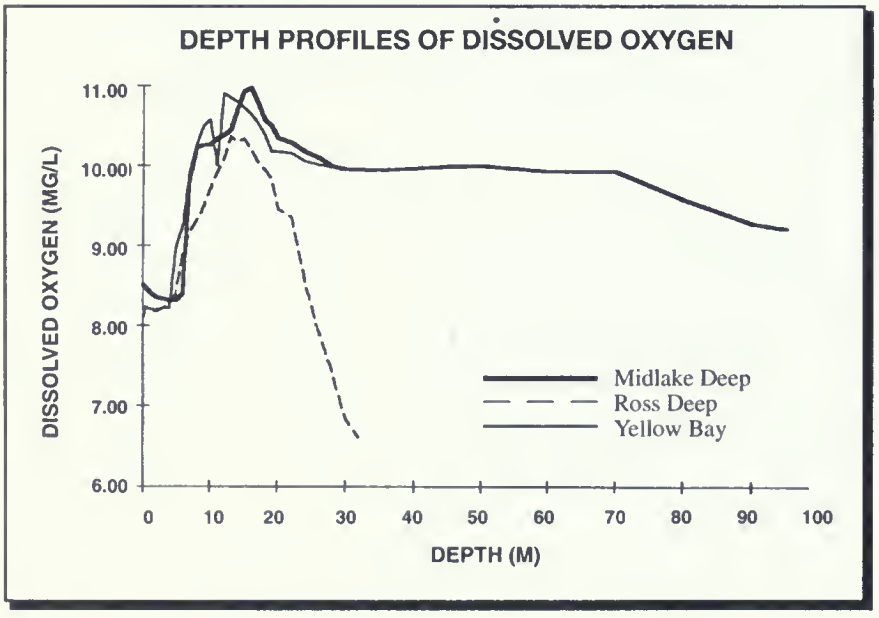
Scientists also continue to monitor water quality trends by examining the mass flux of nitrogen and phosphorus through the lake in relation to primary production (the ability of the lake to grow algae).

General Site Comparisons

Researchers found that water quality at the six additional sites on Flathead Lake varied in similar ways to the long-term monitoring site located in the deepest region of the lake with a few exceptions. Turbidity was always highest near the river mouth and on the west shore of the lake (Lakeside site) due to the Coriolis current (a counterclockwise current created by the earth's rotation) which causes the turbid spring runoff from the Flathead River to flow along the west shore. However, turbidity was also significantly higher at other times of the year at the Lakeside site owing to wind driven resuspension of sediments at that shallow site.

Ross Deep Site

Several major differences in water quality were observed at the Ross Deep site in Big Arm Bay in comparison to the midlake site. Significantly higher levels of algae and particulate organic carbon were observed at Ross Deep, and during the summer period a significant dissolved oxygen sag developed in the deeper waters (Figure 1). Reduced oxygen levels were observed all three summers of the study. This



phenomenon occurred nowhere else in the lake, and, to our knowledge, dissolved oxygen values at these levels were never previously reported for Flathead Lake.

Increased nutrients (phosphorus and nitrogen) from shoreline pollution sources and entrainment of the nutrient-rich spring run off carried into the bay by the Coriolis current are possible factors in the observed decline in water quality in Big Arm Bay. Increased nutrients result in more plant and animal growth, and as this organic matter falls into the deeper waters, it is broken down by bacteria which use up oxygen in the process. The more organic matter present, the more that is available for metabolism by the bacteria and the greater the oxygen consumption. Trout need relatively high levels of oxygen to thrive (about 7 mg/l) and at Big Arm Bay concentrations were less than that.

Variety of Sites Important

Minor differences were observed at other sites, but long-term data collected at the midlake site are representative of most of the lake, with the exception of Big Arm Bay. Continuation of the long-term collection at the midlake site is critically important to assessment of lake water quality. However, routine monitoring in those parts of the lake that appear to be changing is also important. Because bays are shallower and tend to trap nutrients, they may show signs of deterioration before the midlake site.

Analysis of Nutrient Inputs and Outputs

In an analysis of nutrient inputs and outputs, researchers found that over half of the incoming load of phosphorus each year was retained in the lake, stored in the bottom sediments. The phosphorus is held there by the oxygenated water column. Should the water column above the sediments become de-oxygenated, a substantial amount of the stored phosphorus would be released back into the lake and water quality would decline precipitously. This further underscores the concern for the reduced oxygen concentrations observed in the deeper waters of Ross Deep, although values observed to date do not approach anoxia (zero oxygen).

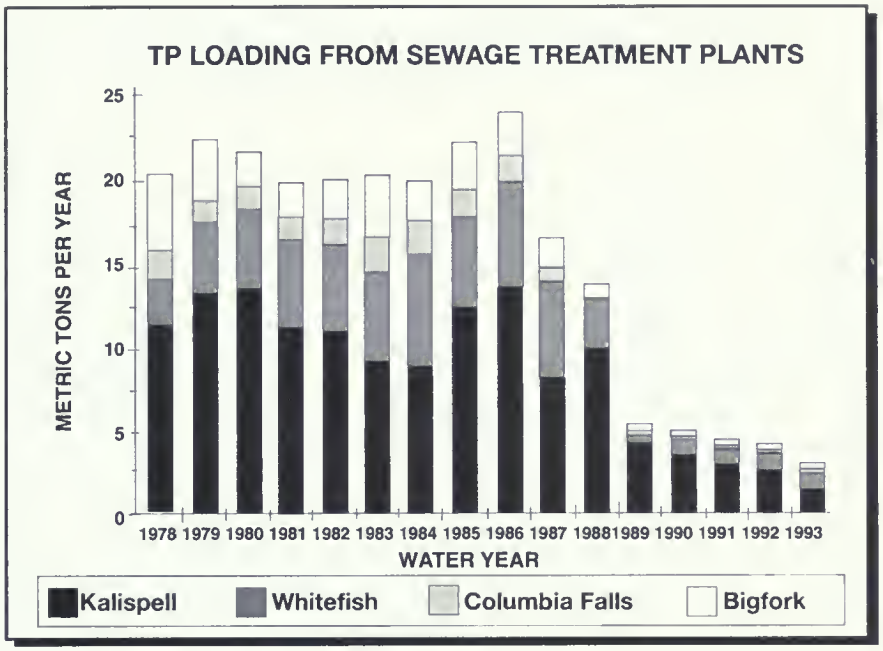
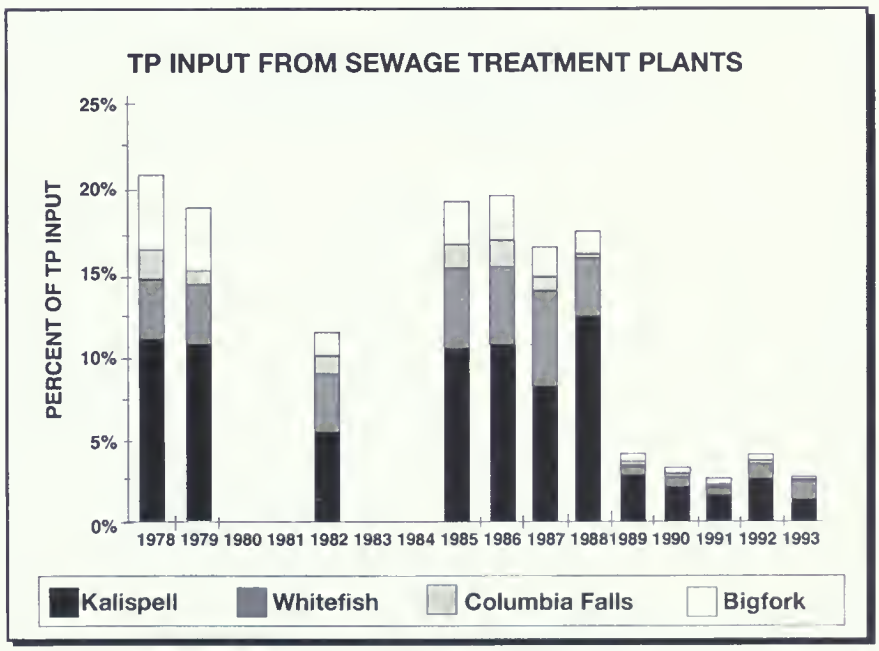


Figure 2. Total load of phosphorus from sewage treatment plants to Flathead Lake (in metric tons per year and percent of total phosphorus input).

Nutrients from Sewage Treatment Plants

A dramatic reduction in the amount of phosphorus coming from urban sewage treatment plants (STP) has occurred since the phosphorus reduction plan was implemented by the Water Quality Bureau. This plan included a ban on phosphate detergents plus major upgrades of the Kalispell, Whitefish, Bigfork and Columbia Falls treatment plants. Indeed, the percent of the total load of phosphorus from STPs to Flathead Lake declined from over 20 percent in 1978 to less that 5 percent since 1989 (Figure 2).



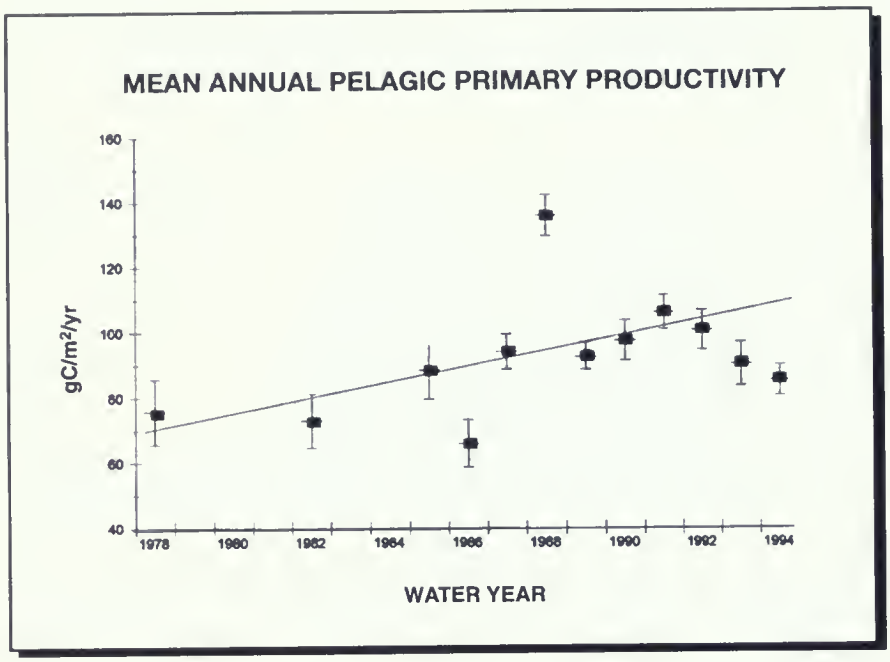
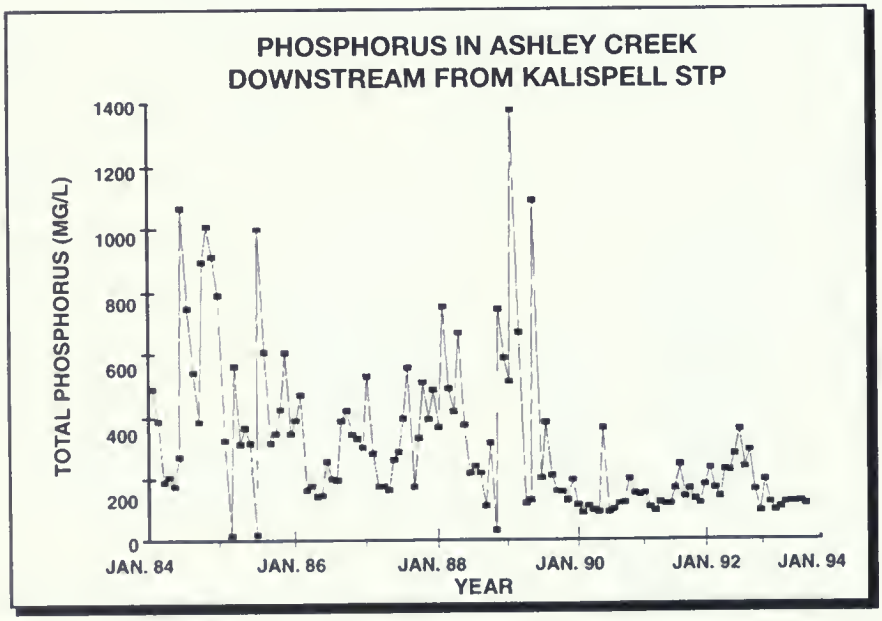


Figure 3. Mean annual pelagic primary productivity (the ability of the lake to produce algae) for Flathead Lake.

Phosphorus in point source sewage discharges is highly available to algae for growth. Reducing these sources of phosphorus loading may be a major reason why primary productivity appears to have stabilized in recent years (Figure 3). Although advances in the removal of phosphorus at the Whitefish STP have greatly reduced total phosphorus concentration in the effluent, population expansion in the Whitefish area has resulted in an increase in the total volume of sewage. The Whitefish STP accounts for almost half of the total phosphorus load from Flathead Valley sewage treatment plants.

Figure 4. Total phosphorus and nitrogen loading to Ashley Creek from the Kalispell sewage treatment plant.



Phosphorus and nitrogen loading to Ashley Creek from the Kalispell sewage treatment plant (Figure 4) decreased after 1989 in response to the phosphorus ban and better technology at the treatment plant. Researchers have examined sediments from Ashley Creek below the Kalispell STP and discovered that they have the potential (under the right conditions) to release massive amounts of nitrogen and phosphorus. Hence, sediment release of nutrients, combined with population growth in the Flathead Valley, may offset improvements in water quality achieved by better sewage treatment. It is very important that the creek remain oxygenated (by eliminating pollution sources above the effluent from the Kalispell STP and by reducing organic matter and nutrients in the Kalispell STP effluent) so that the major load of phosphorus remains adsorbed to the sediments.

Sources of Phosphorus

In all years the Flathead River has been the largest contributor of bioavailable phosphorus to Flathead Lake (Figure 5). However, both wet and dry atmospheric deposition (dust, smoke and other airborne contaminants that fall directly on the lake) are a significant source of phosphorus to the lake (10-38 percent of the total mass input). Contrary to river input, which occurs predominantly in the spring runoff period, sporadic events producing deposition occur year around (though peak phosphorus inputs are common in both spring and fall). While river inflow occurs at the north end of the lake, phosphorus input via the airshed occurs lake wide. The percentage is high relative to other studies, but not surprising given the high level of airshed particulates in the valley. The American Lung Association recently cited Flathead County as one of 16 counties in the U.S. violating federal air pollution standards (PM-10 fine particulate pollution) during 1992.

Stoner Creek, the largest shoreline tributary, was not a significant source of bioavailable phosphorus on a lake-wide basis. Loads from other lake shore sources were insufficient for inclusion in the calculations of phosphorus flux. Although inputs of available forms of phosphorus and nitrogen from shoreline sources are believed to be small in comparison to lake-wide mass flux, they do

produce localized bursts of bioproduction, particularly in the form of algae on rock surfaces. Indeed, at several locations, sewage breakouts have been discovered by the presence of mats of algae.

Shoreline nutrient pollution is a problem in Flathead Lake in some areas, such as Big Arm Bay, and should not be trivialized by the fact that shoreline sources of bioavailable phosphorus are likely small in terms of whole lake flux. Moreover, the base amount of shoreline algae in Flathead Lake is limited by the quantity of phosphorus in the water column, thus we would expect an increase in the growth of these algae with increased phosphorus. An often-expressed complaint by long time shoreline residents is that the "ring around the lake" formed by algal growth is significantly more visible in the last decade.

Primary Productivity

The main indicator of water quality in Flathead Lake is primary productivity, the ability of the lake to produce algae. The long term trend in primary productivity shows some signs of stabilizing (Figure 3). The conditions at the midlake site may be a sign that the basin-wide phosphorus control strategy is working. Or, the data may simply indicate a re-balancing of the lake's food chain disrupted by the accidental introduction of *Mysis* shrimp in the 1980's. The shrimp eat tiny crustaceans, which eat the algae. Levels of *Mysis* peaked in 1986 and then declined dramatically and appear to have stabilized (Figure 6). The mean density of *Mysis* shrimp in 1993 was 18.8 shrimp per square meter, but numbers rose again in 1994 to 26.3 per square meter. Researchers believe that the density of *Mysis* shrimp will continue to oscillate in the range of the 1989-1992 data as long as the food web remains the same. If another exotic species is introduced into the lake or if anglers over-harvest one of the sport fishes, *Mysis* shrimp densities may fluctuate dramatically again. See the Flathead Basin Commission 1991-1992 Biennial Report for additional information concerning the introduction of *Mysis* and its effects on the lake food web.

Other Primary Production Influences

Primary production in Flathead Lake may also be influenced by other processes such as:

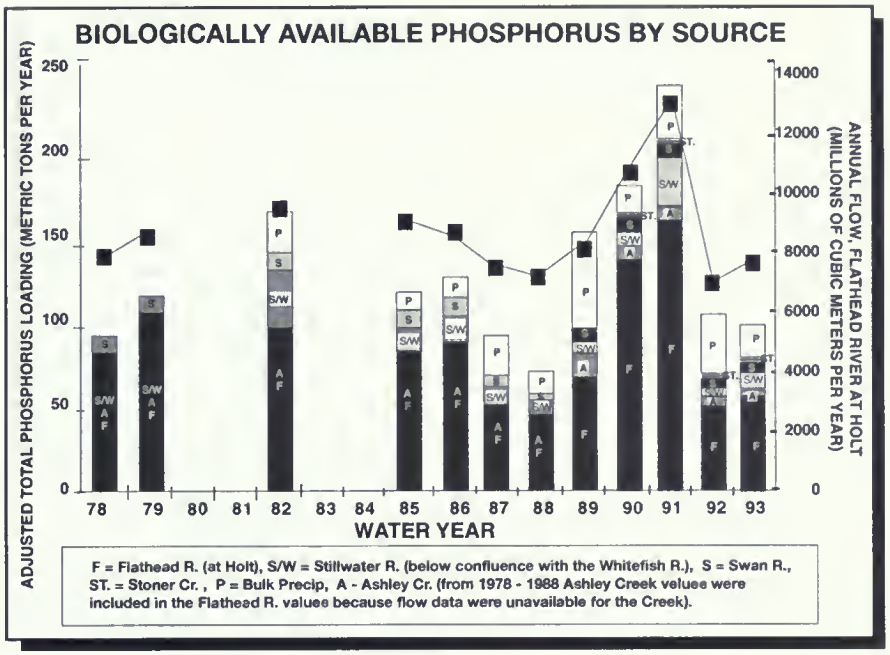
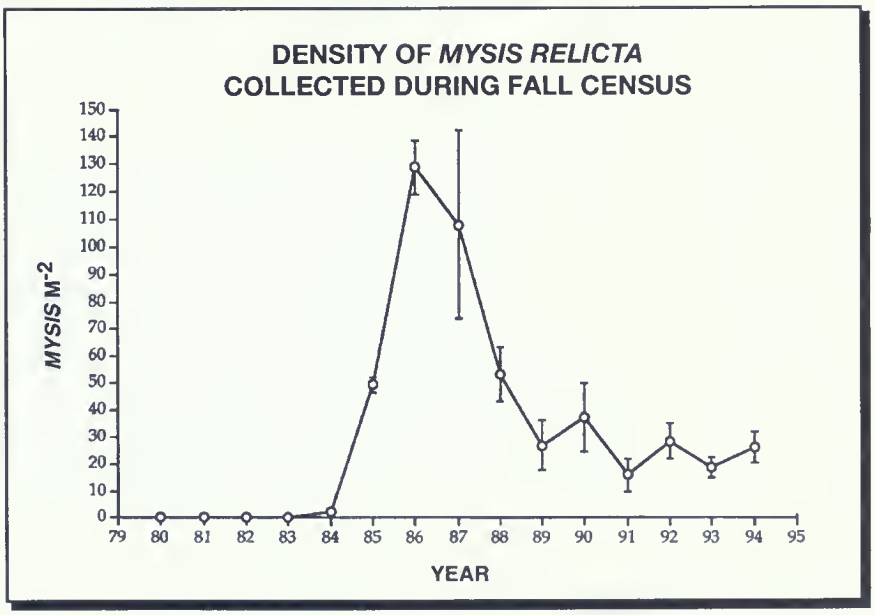


Figure 5. The mass of biologically available phosphorus by source (histograms) reaching Flathead Lake annually in relation to annual inflow from the Flathead River (closed squares).

1) the pattern and timing of water delivery to the lake through the operations of Hungry Horse and Kerr dams, 2) the depth and duration of the mixed layer of the lake in relation to patterns of temperature stratification, and 3) seasonal or shorter term changes in the availability of phosphorus, nitrogen and inorganic carbon to algae in relation to light available for photosynthesis. These are some of the more important processes that continue to be quantitatively examined by researchers.

For background information and previous studies on Flathead Lake and Its Tributaries, see "1992 Flathead Basin Commission Biennial Report" available from Flathead Basin Commission, 723 Fifth Avenue East, Kalispell, MT 59901, 406-752-0081.

Figure 6. The mean density of *Mysis* shrimp since introduction into Flathead Lake.



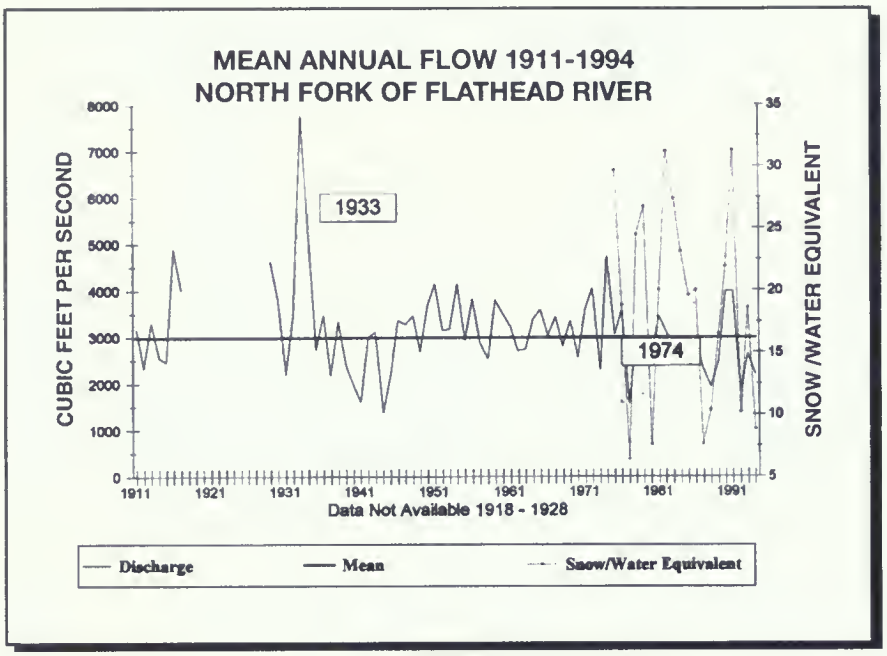
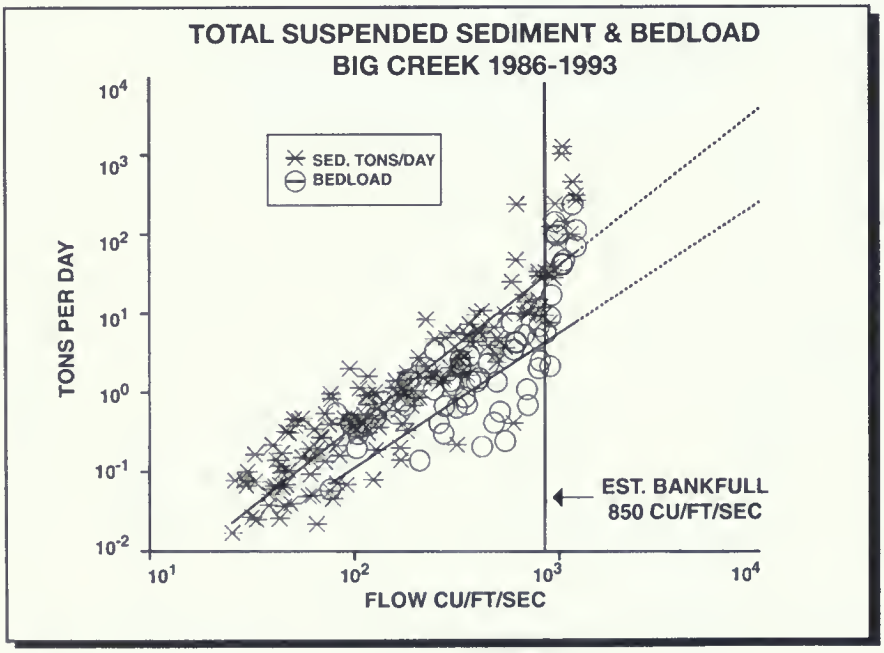


Figure 7. Variability of annual stream flow as values of discharge and snow pack in the form of water equivalents for the North Fork of the Flathead River.

Details of the information presented in this summary can be obtained by requesting a copy of the 1994 "Diagnostic Analysis of Annual Phosphorus Loading and Pelagic Primary Production in Flathead Lake..." by Jack Stanford, et al, available from the University of Montana Biological Station, 311 Bio Station Lane, Polson, MT 59860-9659.

Figure 8. Correlation between measured discharge and sediment on Big Creek, a headwater stream in the Flathead Basin.



Water Quality in Headwater Streams (National Forests)

The Flathead National Forest has had an active water quality monitoring program since the 1970s. Sampling strategies have focused on baseline, trend and activity monitoring for a wide range of watershed characteristics. Analysis of this historic information can be found in earlier Flathead Basin reports as well as Forest documents.

Snow Accumulations/Water Equivalents

As mentioned in previous reports, annual stream flow in the Flathead Basin is highly variable from year to year, as is snow accumulations. These in turn produce wide ranges in total sediment and nutrients such as phosphorous. Figure 7 displays this variability as values of discharge and snow pack in the form of water equivalents for the North Fork of the Flathead River. Although a somewhat limited time period is available for values of annual snow/water equivalents, it can be seen that the tie between runoff an snow is unpredictable. Note that although 1993 was considered a very wet year, both annual discharge and input of water were below the long term averages.

Discharge and Sediment

In most stream systems, the larger the stream discharge, the more energy there is to erode and transport sediments. Many research projects have shown that the major channel-forming processes occur when a stream is at or above 70 percent of bankful. This has been found to hold true in the Flathead as well. Figure 8 displays the correlation between measured discharge and sediment on Big Creek. This long term record reveals a considerable increase in both suspended sediment and bedload (larger particles bouncing or rolling along the stream bottom during high flows). Although this jump in values has been found to exist in many research watersheds and is therefore expected in this region, how much of a change is predictable, given local conditions, is currently unknown.

Categorizing the Interpretations

Monitoring and interpreting features of aquatic systems pose many challenges because there are many processes that influence their

pattern and character. Dave Rosgen, a well known geomorphologist, has noted that what initially appears very complex, is often even more so when measured and studied in depth. One method currently being used to simplify interpretations of the river systems is to categorize them with channel morphology or form, along with other aquatic characteristics. This information is used in Forest level landscape-wide ecosystem analyses, and is being integrated into the broader Upper Columbia River Basin Study currently under way.

Although this effort is not a direct part of the Flathead Basin monitoring plan, it will play an important role in furthering the knowledge of local river systems. Generally this effort will be used to: 1) help predict a stream's behavior from its appearance, 2) extrapolate specific data collected on a given stream to another of similar character, 3) provide a consistent and reproducible frame of reference to predict potential habitat conditions for fish or other aquatic resources, and 4) predict changes in channel form in relation to changes of upland features such as vegetation.

In the past two years, the Forest has classified over 35 sites using the Rosgen classification system. Streams chosen for inventory include existing water quality monitoring sites within the Forest boundary and some "reference streams" from other unmanaged areas such as Glacier Park or wildernesses. The Rosgen system uses several characteristics for its classification such as: channel gradient (measured as energy slope of the water surface); sinuosity (ratio of channel length to valley length); width/depth ratio (width at bankful stage divided by bankful depth); dominant particle size of bed and bank materials; entrenchment of channel and confinement of channel in valley; and landform features, soil erodibility and stability. It has been found that stream morphology and related channel patterns are directly influenced by several major variables: width, depth, velocity, discharge, slope, roughness of channel materials, sediment load and sediment size, and that a change in any one variable sets up a series of concurrent changes in the others. This can be traced to altered channel patterns and habitat characteristics.

When used with existing data (such as sediment and nutrient values) collected by the Forest and other cooperating groups, classifications will be used to help predict the health of fish habitat and help prioritize fish habitat improvement projects and stream restoration projects. Classifications can also help explain channel stability changes and their relationship to terrestrial modifications.

Other Surveys

Several other surveys have been conducted at the same time the streams have been classified to further help the interpretation of physical water quality data. Some of these include channel stability ratings, cross-sectional profiles, Tarzwell (an index of particle sizes in the stream bottom), and Riffle Stability indexes (an indication of how much of the stream bottom material is moving during peak flow events). Results of some of these analyses will be presented in the Forest Plan Monitoring reports in coming years.

Water Samples

Water samples are currently being analyzed for eight stream sites across the Forest as outlined in the Monitoring Master Plan. These chemical analyses will characterize three sites on Coal Creek on the North Fork of the Flathead, Challenge Creek in the Middle Fork drainage, and three locations in the Swan Valley. Two other sites in the South Fork were not sampled due to access difficulties and other Forest priorities. Sample testing and analyses are contracted to the Flathead Lake Biological Station. Results and conclusions will be presented in future reports.

For background information and previous studies on water quality in headwater streams, see "1992 Flathead Basin Commission Biennial Report" available from The Flathead Basin Commission, 723 Fifth Avenue East, Kalispell, MT 59901, 406-752-0081.

For more details on the information presented in this summary contact the Flathead National Forest, 1935 3rd Ave. East, Kalispell, MT 59901.

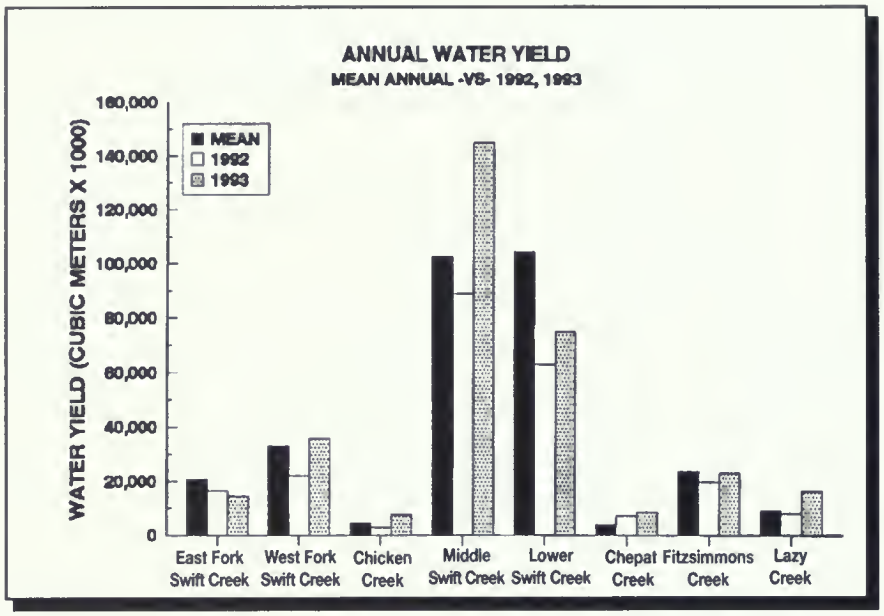


Figure 9. Annual water yield across Stillwater State Forest sampling sites.

Water Quality in Headwater Streams (State Forests)

The Montana Department of State Lands (DSL) has monitored water quality at selected sites in the Whitefish and Stillwater river basins since 1976. The objective is to detect trends in discharge, nutrients, and sediments, to identify relationships, and to establish baseline values for comparison.

Water Yield

Water yield, or production, during 1992-1993 was highly variable across the sampling sites, ranging from 40 percent below to 150 percent over the mean annual yield. (Figure 9) The differences in generalized water yield over time may be due to chance or to management activities in the project area. However, the period of record is too short to discern statistically valid hydrologic trends.

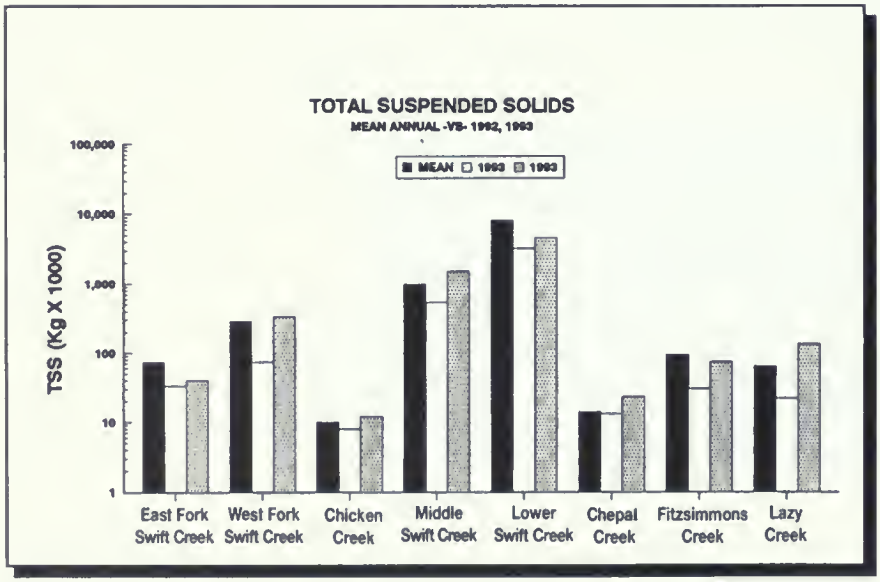


Figure 10. Total suspended sediment yields for each sampling station in the Stillwater State Forest.

Sediments

Hydrologists use trends and deviations from normal suspended sediment concentrations and loads to measure and detect changes in water quality. The most recent samples of total suspended sediment (TSS) at monitoring points in the Stillwater State Forest show some changes from mean annual yields. Figure 10 shows TSS mean annual yields for each station over the entire period of record (1976-1993) and values for 1992 and 1993.

Average annual TSS yields at stations upstream from Lower Swift Creek indicate sedimentation rates are within the expected range for glaciated belt geology in a natural state. Higher TSS yields for Lower Swift Creek were likely due to the large volume of sediment available from mass-wasting banks (landslides) along the stream between Middle Swift and Lower Swift sites. At these locations, Swift Creek continues to undercut glacial and fluvial deposits.

TSS yields for Lower Swift Creek were consistently 5 to 10 times greater than for Middle Swift Creek at high flow. Over the two year period, 1992-1993, the annual TSS yield at Lower Swift was 4.5 times greater than Middle Swift, 104 times greater than the East Fork Swift, and 15 times greater than West Fork Swift. These data suggest that approximately 74.5 percent of the average annual sediment measured at the lower station originates in the eight to ten miles of the stream between the Middle and Lower Swift stations. Lower Swift Creek was the only station to have TSS concentrations above 100 mg/l. But, as expected, these high TSS concentrations correspond with high spring runoff stream discharges, and there is a direct correlation between sediment yield and discharge.

Nutrients

Phosphoros

Phosphate values in Swift Creek are of special interest because of the nutrient status of Whitefish Lake. Studies of Whitefish Lake have concluded that increasing nutrients will further stimulate algal productivity and should be avoided, if possible..

Previous studies have suggested that the primary sources of phosphate in the drainage were from decomposed organic matter and phosphorus compounds stored on sediments. Concentrations of phosphorus are thought to increase as flow increases, indicating a surface source rather than a groundwater source. Phosphorus concentrations generally showed a direct correlation with discharge and TSS.

The monitoring conducted to date suggests that there is no direct relationship between phosphorus concentration and forest development. Chicken Creek, a baseline station, had the lowest mean annual sediment yield and a higher phosphate yield than the West Fork Swift and East Fork Swift. Both the East Fork Swift and West Fork Swift drainages have had considerable harvest and road building activity.

Total phosphorus exceeded the level generally accepted as the water quality standard by the Montana Water Quality Division on two occasions in 1992 and two in 1993 in Lower Swift Creek. All high phosphorus levels coincided with the timing of spring runoff. Figure 11 shows the calculated total phosphorus yields for all stations and compares them with mean annual values.

Ortho-phosphorus accounted for 14 percent of total phosphorus measured at Middle Swift for 1992-1993, but only 6 percent of total phosphorus at Lower Swift. Ortho-phosphorus yields for the remaining stations in the Swift Creek drainage were roughly 35, 17, and 56 percent for East Fork Swift, West Fork Swift, and Chicken Creeks, respectively. Figure 12 depicts ortho-phosphorus yields for all stations in 1992 and 1993 compared to mean annual yields. High yields from Lazy Creek are thought to be related to runoff from agricultural and pasture lands immediately adjacent to the lower reaches of the creek.

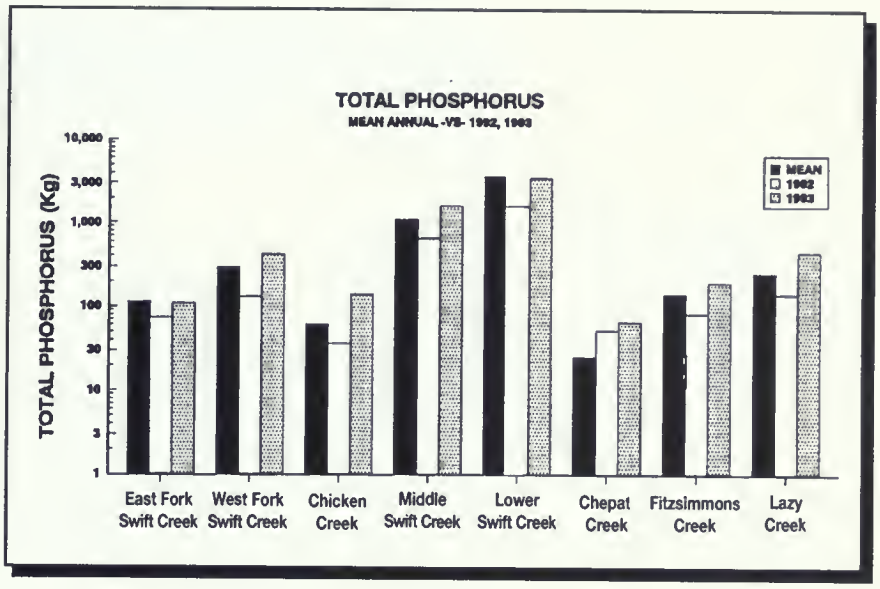
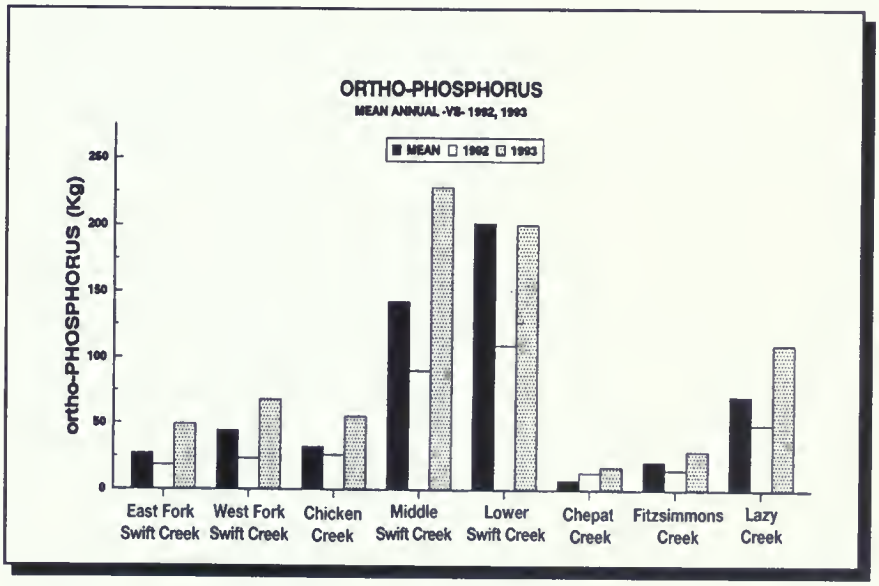


Figure 11. Stillwater State Forest's calculated total phosphorus yields for 1992 and 1993 compared to mean annual values.

Overall, the high total phosphorus yields were almost certainly related to sediment resulting from mass-wasting channel banks along the stretch of Swift Creek between the two sites. With mass-waste prone stream banks between Middle Swift and Lower Swift, it was virtually impossible to detect changes strictly related to land management activities. The amount of sediment added to Swift Creek due to natural geological processes most likely masks any subtle changes that may have occurred as a direct result of management activities.

Figure 12. Ortho-phosphorus yields for 1992 and 1993 compared to mean annual yields on the Stillwater State Forest.



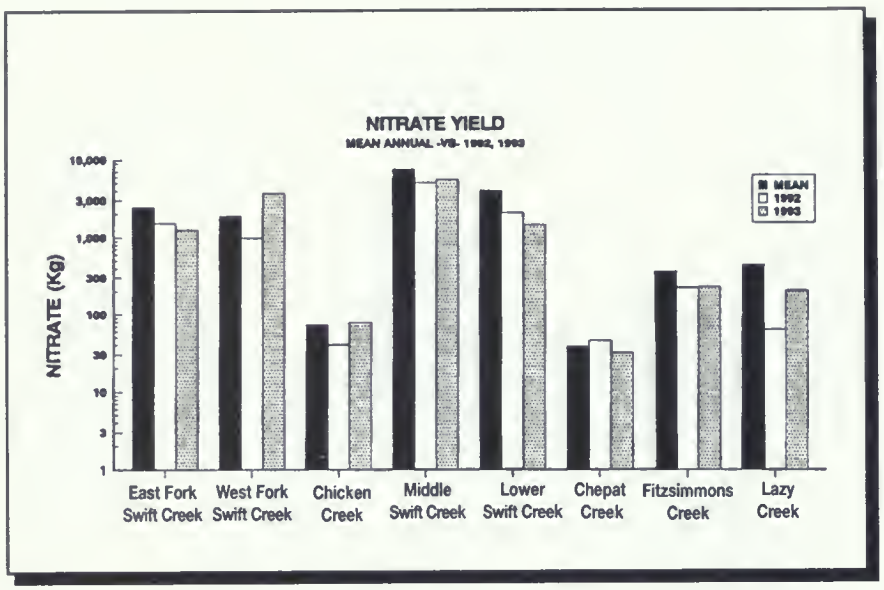


Figure 13. Nitrate yields at monitoring sites on the Stillwater State Forest for 1992 and 1993 compared to mean annual yields.

Nitrate

Nitrate concentrations at all stations were well below the 0.30 mg/l concentration recommended by the Water Quality Division for all but one monitoring date. In May 1993, West Fork Swift had a measured nitrate concentration of 0.60 mg/l. The previous highest recorded concentration was at East Fork Swift with a value of 0.21 mg/l in 1985. Overall, East Fork Swift had the highest values for nitrate, which may be due to a smaller contributing area and a larger water yield per unit area, when compared to other stations. Typical nitrate concentrations during spring runoff (1992-1993) at Lower Swift averaged 0.0144 mg/l while nitrate at East Fork Swift averaged 0.1332 mg/l. Figure 13 gives yields for all stations for 1992 and 1993 compared to mean annual yields.

ANCOVA

An analysis of covariance (ANCOVA) was completed on the entire 1976-1993 data set to determine the existence of any trends in TSS concentration as related to streamflow. TSS was chosen because it is the water quality parameter with the highest potential for impacts from forestry operations. Because phosphorus levels appear to be directly linked to TSS, the analysis of TSS versus discharge may also lead to inferences about phosphorus relationships. All stations had statistically significant differences in adjusted means for the yearly TSS versus discharge relationships. It is likely that differences shown in the ANCOVA analysis were due to natural variability of seasonal flow regimes and/or timing of sampling.

For background information and previous studies on water quality in headwater streams, see "1992 Flathead Basin Commission Biennial Report" available from The Flathead Basin Commission, 723 Fifth Avenue East, Kalispell. MT 59901, 406-752-0081.

Details of the information presented in this summary can be obtained by requesting a copy of the 1994 "Surface Water Quality of the Stillwater State Forest" by Mark D'Aversa, available from Montana Department of State Lands, 2705 Spurgin Road, Missoula, MT 59801

Lower Flathead River Basin/ Flathead Indian Reservation

The Lower Flathead River Basin is that portion of the watershed from the outlet of Flathead Lake at Polson to the confluence of the Flathead and Clark Fork rivers near Paradise, Montana. This area is contained almost entirely within the boundaries of the Flathead Indian Reservation. The Confederated Salish and Kootenai Tribes' Natural Resources Department is responsible for water quality monitoring on the Reservation, which also includes the south half of Flathead Lake.

Monitoring Program

The Tribal Water Quality Program implemented a Reservation-wide surface water quality monitoring program in 1992. Since then monitoring on the Reservation has expanded from 20 to 30 sites. In addition to the sites which are monitored monthly, sampling programs are also conducted for specific projects such as homesite developments, herbicide applications, and disaster/emergency services. Data from the monthly sampling program are currently being analyzed, and a second Flathead Reservation Assessment Report will be completed in early 1995.

TMDL

In 1993 the Tribal Water Quality Program became involved in a Total Maximum Daily Load (TMDL) study on Flathead Lake. A grant was received from Region 8 of the U.S. EPA to perform a land use inventory and water balance analysis of the near shore area of the lake to determine nutrient (phosphorous and nitrogen) loading. The Tribes are working cooperatively with the state of Montana and EPA and will

assist in the determination of an acceptable nutrient load to the lake. To add to the baseline information needed for the TMDL, and as part of the monitoring network expansion, additional Flathead Lake tributaries — Yellow Bay, Teepee, and Boulder creeks — were added to the sampling program.

BMPs

Other progress made by the Tribes to manage and protect water resources on the Reservation includes the development of forestry Best Management Practices (BMPs). The Tribal Council will vote on adoption of these BMPs into the upcoming Forest Management Plan in early 1995. In addition, the Tribes have sought assistance from the Bureau of Reclamation to determine the origins of nonpoint source pollution to the Lower Flathead River. Control strategies will also be developed to decrease the amount of nutrients and sediment to this section of the river from improper agricultural practices.

Standards and Classifications

The most important administrative task accomplished since 1992 has been the review and revision of the Tribal Water Quality Standards and Classifications. An application for Treatment as a State (TAS) under Section 303 of the Clean Water Act was submitted to EPA in 1992. The review and revision of these standards was performed in the summer and fall of 1993. A public hearing was held in January 1994. No comments were received at the hearing, and virtually all comments received during the open period were concerned with jurisdictional rather than technical issues. The Tribes are still awaiting a formal decision on their TAS application.

For background information and previous studies on the Lower Flathead River Basin, see "1992 Flathead Basin Commission Biennial Report" available from The Flathead Basin Commission, 723 Fifth Avenue East, Kalispell, MT 59901, 406-752-0081.

Details of the information presented in this summary can be obtained by requesting a copy of the 1994 "Flathead Basin Commission: Biennial Report Water Quality Monitoring—Lower Flathead River Basin/Flathead Indian Reservation, by Dave Haire, available from Confederated Salish & Kootenai Tribes, Natural Resources Dept., P.O. Box 278, Pablo, MT 59855.

Fisheries

Three sport fish species (bull trout, westslope cutthroat trout and kokanee salmon) continue to be of major concern in the Flathead Basin. Bull trout and cutthroat trout are particularly sensitive to environmental disturbances and are used as indicators of in-stream environmental quality. The numbers of these fish, along with kokanee salmon, have shown a marked decline in many areas of the Flathead River Basin during recent years.
Ongoing research in the basin involves counts of "redds" (spawning nests) and juvenile fish populations of bull trout and westslope cutthroat trout, as well as counts of kokanee salmon.

Information from these research projects is being used to evaluate fish habitat quality and formulate recommendations for management actions.

Bull Trout

Redd counts have been conducted in many areas of the Flathead River Basin. Areas covered include the North and Middle Forks of the Flathead River, the Swan Drainage, and the area above Hungry Horse Reservoir. In addition, FWP also completed spawning surveys on several areas with smaller populations during fall of 1994. These included Big Salmon, Upper Kintla, Tally, Lindbergh, Cyclone, Whitefish and Upper Whitefish lakes.

During the past 16 years, Montana Fish Wildlife and Parks (FWP) has monitored known spawning areas in tributaries of the North and Middle Forks of the Flathead River. Fish that use these streams travel from Flathead Lake to spawn.

Four tributaries in the Swan have been monitored for 13 years. The drainage is cut off from the Flathead population by Bigfork Dam. These fish spend their adult lives in Swan Lake but spawn and rear in Swan River tributaries upstream from the lake.

Hungry Horse Reservoir also supports an isolated bull trout population above Hungry Horse Dam. These fish spawn and rear in tributaries of the reservoir itself as well as those

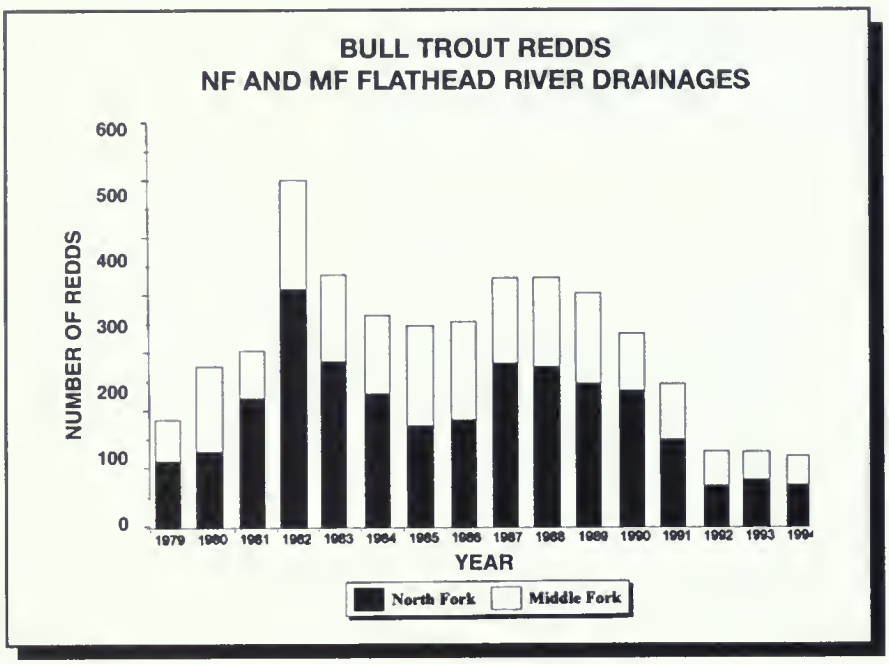


Figure 14. Bull trout redds (nests) in the North Fork and Middle Fork of the Flathead River.

draining into the South Fork of the Flathead River above the reservoir. Bull trout redd counts were initiated in the South Fork Drainage in 1993. Based on first year findings, four reservoir tributaries and four upper basin tributaries were selected for long-term monitoring.

Flathead Lake Spawning Run

The 1994 spawning run out of Flathead Lake was well below historically measured levels. (Figure 14) Over the past 15 years, North Fork monitoring counts have averaged 200 redds. The 1994 count of 64 is 68 percent lower than average. Middle Fork monitoring areas have averaged 125 redds during the same 15 year period. This year's count of 51 equals the record low number set last year and is 59 percent below average. The combined lake average is 327 redds. This year observers found 115, which is the lowest on record, or 65 percent below average. All eight streams were well below average. Counts in Coal, Lodgepole and Ole creeks set new record lows.

Swan Lake Spawning Run

1994 redd numbers for the Swan drainage indicate the bull trout spawning run was the largest on record. (Figure 15) Over the past 12 years, the total for the four monitoring areas averaged 288 redds. The 1994 count of 493 is the highest observed and 71 percent above average. All four Swan monitoring streams contained well above the average number of redds. Goat and Lion creeks had new record high counts this year.

Hungry Horse Reservoir - South Fork Flathead Spawning Run

Redd counts were completed in the South Fork Drainage for the first time in 1993, so comparisons with "long-term averages" are not possible. 1994 counts are similar to the 1993 counts. Reservoir tributaries contained slightly fewer redds this year compared to 1993, but slightly higher redd numbers were observed in upper river tributaries.

Disjunct Populations Spawning Runs

Due to the overall lack of information regarding regional bull trout populations other than the three previously discussed, FWP initiated spawning surveys on seven smaller, separate or disjunct populations.

The bull trout population in Big Salmon Lake spawn and rear in Big Salmon Creek above the lake. Based on two years of information, this population appears stable: 92 redds were observed in 1993 and 91 in 1994. Upper Kintla Lake in Glacier National Park supports a unique bull trout population: these fish run downstream to spawn. In 1994, the first year the area was surveyed, 51 redds were found in the first 1,000 paces below the lake. A waterfall forms a barrier that blocks migration beyond this point.

During first year research, field crews also counted seven bull trout redds in Logan Creek above Tally Lake, 26 redds in the Swan River above Lindbergh Lake; five redds in the first 1,000 paces below the outlet at Cyclone Lake; no redds in the Swift Creek Drainage above Whitefish Lake, in the West Fork of Swift Creek, or in the East Fork of Swift Creek. Outlet spawning is possible in several of these areas. A November survey was planned for those spots. A basin-wide count is also scheduled for 1995.

Juvenile Bull Trout

Researchers have identified Morrison Creek in the Middle Fork drainage and main Coal Creek in the North Fork drainage as two key index streams for monitoring juvenile bull trout. In recent years, juvenile bull trout populations have declined to their lowest levels in both of these streams. (Figure 16) Since 1989,

researchers have found that the number of juvenile bull trout in the North Fork of Coal Creek has decreased dramatically. In 1994, the population reached the lowest point since sampling began in 1982.

Westslope Cutthroat Trout

Biologists completed westslope cutthroat trout redd counts in several tributaries to Hungry Horse Reservoir this year. Researchers attempted to classify redds by life history, based on size of the spawning site. (Resident fish construct smaller redds; migratory fish build larger redds.) The 1994 spawning run out of Hungry Horse Reservoir appeared to be within the range observed during past years. Observers noted more signs of channel instability in Hungry Horse Creek than in past surveys. Extensive channel migrations are occurring with large areas of bedload deposition. All westslope cutthroat trout spawning in Margaret Creek occurred above the Road #38 crossing. Approximately half of the spawning in McInernie Creek was above Road #38. Field crews also observed nine migratory cutthroat trout redds in Riverside Creek. All nine were below the Road #38 crossing. Also noted was limited spawning by resident fish above Road #38 in Riverside Creek.

Researchers have concentrated on identifying those areas where genetically pure populations of westslope cutthroat trout can still be found throughout the Flathead River drainage. Since 1992, six new populations of westslope cutthroat trout on the Flathead Reservation have been verified by the University of Montana Genetics Lab as genetically pure.

Kokanee Salmon

Kokanee salmon were introduced into Flathead Lake in 1916 and became an integral part of the Flathead Lake ecosystem, sport fishery and area economy. Kokanee numbers rapidly declined in the late 1980s. Researchers state that the decline is related to factors such as competition with *Mysis* shrimp, predation, and the effects of operations of Kerr and Hungry Horse dams. At present, researchers believe kokanee have disappeared from the interconnected Flathead system, although populations are still maintained in other basin areas such as Swan Lake and Ashley Lake.

Since 1990, surveys have found no redds in McDonald Creek, in several mainstem Flathead River sites near Columbia Falls, or in several

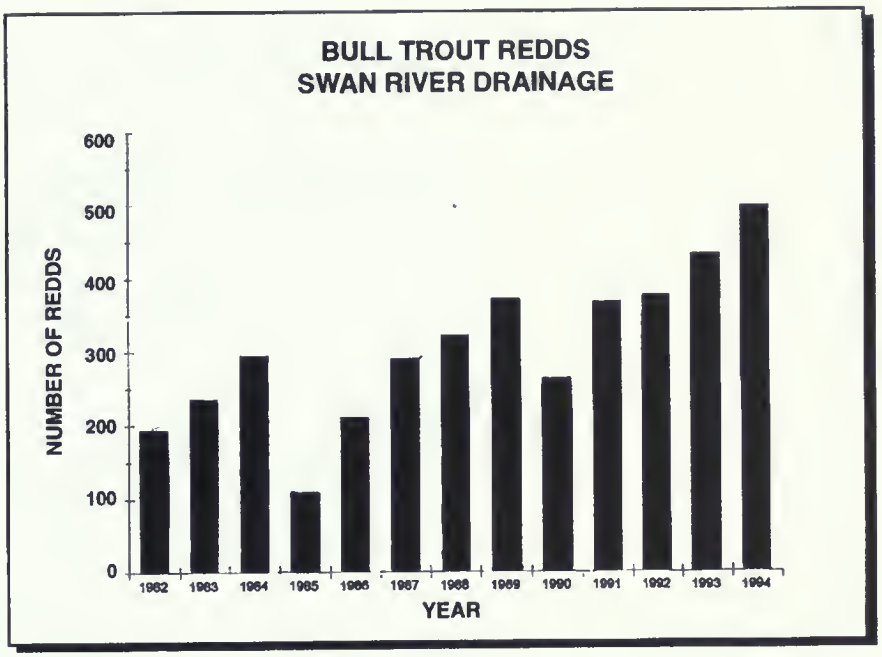


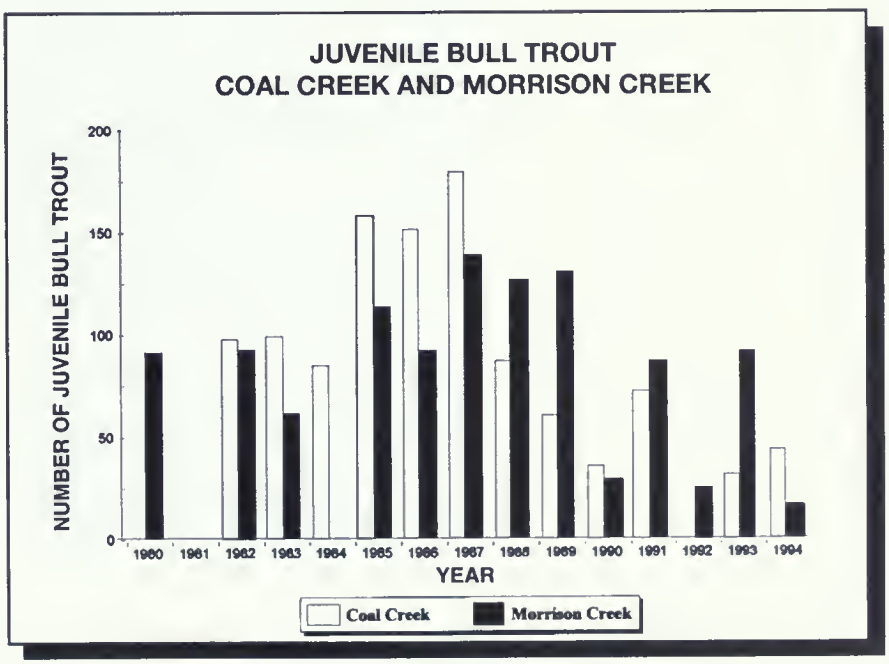
Figure 15. Bull trout redds (nests) in the Swan River drainage.

Flathead lakeshore sites. However, Swan Lake was reported to support about 1500 redds annually between 1992 and 1994.

Lower Flathead River

Currently, the Confederated Salish & Kootenai Tribes have identified severe drawdowns and hybridization with brook trout to be the two primary factors limiting bull trout abundance upstream of Mission Dam. In 1991 the Flathead Agency Irrigation Project implemented a new minimum pool level designed to enhance over-winter survival of bull trout. Since 1992, the Tribes have been quantifying the rate of hybridization between brook and bull trout

Figure 16. Counts of juvenile bull trout in Coal and Morrison creeks, two key index streams



in the North Fork drainage.

and are monitoring the results of efforts to remove brook trout from the system. The bull trout above Tabor Dam are limited by inadequate spawning habitat, which only exists within the drawdown area of the reservoir. Since 1993, lake levels have been managed to avoid dewatering migration barriers which has facilitated access into critical spawning reaches. During this period, a significant increase in spawning success has been documented.

Flathead Lake

In the last decade, the fish species composition of Flathead Lake has dramatically changed. There has been a shift in the gamefish community from one dominated by lake whitefish, bull trout, westslope cutthroat and kokanee salmon to one dominated by lake whitefish, lake trout and westslope cutthroat trout. A gill netting monitoring program (one method of monitoring this change in specific areas at specific times of year) was established and implemented in the early 1980s prior to the shift in fish species. The program was discontinued in the mid-1980's, but was reinstated in 1990. Much of the data collected has yet to be analyzed. In winter 1994-95, analysis of species composition and fish-per-net will be completed.

For background information and previous studies on fisheries, see "1992 Flathead Basin Commission Biennial Report" available from The Flathead Basin Commission, 723 Fifth Avenue East, Kalispell, MT 59901, 406-752-0081.

Details of the information presented in this summary can be obtained by requesting a copy of the 1994 "Monitoring Fisheries Habitat and Fish Populations in the Flathead Basin" by Tom Weaver, available from Montana Department of Fish, Wildlife and Parks, 490 N. Meridian Rd., Kalispell, MT 59901, 406-752-5501.

Forestry Practices Update

Best Management Practices (BMPs) are voluntary guidelines that establish minimum accepted standards for timber harvesting, road building, and other forest operations activities. The objective of BMPs is to protect water quality.

Since their formalization through legislative action in 1989, BMPs have helped those involved in timber management improve the application and effectiveness of their management practices.

Results of the 1994 audit show that 91 percent of the applications of practices met or exceeded BMP requirements, an improvement of four percent from 1992 and 13 percent from 1990.

For a detailed account of BMP audits, please refer to "Montana Forestry Best Management Practices Implementation Monitoring -- The 1994 Forestry BMP Audits Final Report", available from Montana Department of State Lands, Forestry Division, 2705 Spurgin Road, Missoula, Montana 59801.

The effect of forestry practices on the aquatic environment is further minimized through adherence to Montana's Streamside Management Zone (SMZ) law, which went into effect in 1993. The law applies to water courses that meet the definition of a stream, lake, or Other Bodies of Water (OBW) in instances where forestry practices meet the definition of a timber sale.

The SMZ law creates a buffer zone adjacent to aquatic environments that helps keep sediment out of the water. For additional information, please refer to "Guide to the Streamside Management Zone Law & Rules", available from Montana Department of State Lands, Missoula, or from local DSL offices.

For comprehensive information relating to the affect of forestry practices on water quality and fisheries in the Flathead Basin and criteria developed to protect those resources, please refer to "Flathead Basin Forest Practices Water Quality and Fisheries Cooperative Program Final Report", available from the Flathead Basin Commission. The report summarizes 10 individual studies conducted in the basin relating to the historical perspective, water quality and fisheries, evaluation of forest practices, and evaluation of watersheds.

Private Sector Activities

Since 1992, Plum Creek Timber Company, L.P., the largest private landowner in the Flathead Basin, has conducted a variety of water quality monitoring and stream enhancement projects in the basin. The work has primarily addressed recommendations made in the 1991 Flathead Basin Forest Practices Water Quality and Fisheries Cooperative Study.

Specifically, work undertaken has included implementing watershed level analysis and planning, ameliorating existing sediment sources associated with older roads, obtaining fisheries information in unresearched drainages, and monitoring the percentage of fine sediment in spawning gravels in selected bull trout streams.

Jim Creek and Lion Creek Fine Sediment Levels

Plum Creek has conducted sampling of fine sediment on Jim and Lion creeks in the Swan River drainage since 1992, continuing work that was begun by MFWP in 1990. Lion Creek is considered to be the "unmanaged" comparison by which Jim Creek can be evaluated.

Data show that mean fine sediment levels in both creeks are typically in the range of 38 percent to 45 percent and that Jim Creek fine sediment levels are closely tracking those of the undisturbed comparison stream.

Bull Trout Presence/Absence Surveys

Over the past two years, Plum Creek has surveyed a number of streams in the upper Flathead Basin to expand the existing knowledge of fish distribution. No bull trout were documented in Beaver Creek (tributary to Swan River), Dayton Creek (tributary to Flathead Lake), and Lazy Creek, (tributary to Whitefish Lake). In Lazy and Dayton creeks, only eastern brook trout were found. Beaver Creek was found to have cutthroat, eastern brook, and rainbow trout.

Riparian Fencing Projects

In 1993 and 1994, Plum Creek fenced off approximately seven miles of upper Flathead Basin riparian areas from livestock grazing, including areas on Kessler Creek (tributary to Mount Creek) and Donaldson, Freeland, and Hillburn creeks (tributaries to Lake Mary Ronan). Plum Creek now requires that range management plans be submitted by all their lessees and that each lessee perform riparian monitoring at least twice a year.

Mount Creek Analysis and Management Plan

Mount Creek, a fourth order tributary to Ashley Creek, located approximately 15 miles southwest of Kalispell, has a long history of timber management, grazing and other agricultural uses. The area has recently seen an increase in the number of small "hobby" farms. In 1993, Plum Creek developed a management plan for company lands in the drainage initiated by concerns raised by the Montana Cumulative Watershed Effects Cooperative.

The plan was based on a watershed conditions analysis consisting of a series of resource assessments directed at watershed processes/hazards. These included: mass wasting (landslides), surface erosion, stream channel condition, fish habitat and other factors. Once the resource assessments were completed, existing and potential cause/effect relationships between the hillslope processes and in-channel or fisheries beneficial uses were identified.

Based on the identified problems, a management plan was developed which targeted the specific issues for long-term improvement. Monitoring will be done biennially, and in 1998 the drainage will be reevaluated by Plum Creek to determine whether the management plan needs to be modified. Key components of the Mount Creek management plan include timber management prescriptions, road prescriptions, grazing prescriptions, and a variety of other measures.

Details of the information presented in this summary can be obtained by requesting a copy of "Water Quality-Related Activities by Plum Creek Timber Company in the Upper Flathead River Basin, 1992-1994," by Brian Sugden, available from Plum Creek Timber Company, P.O. Box 160, Columbia Falls, Montana 59912.

PCBs in Flathead Waters

Moderately high levels of mercury and PCBs (polychlorinated biphenyls) were measured in lake trout collected in 1993 and 1994 from Flathead Lake, one of 20 Montana lakes surveyed for these toxic chemicals by the Montana Department of Fish, Wildlife and Parks and the Montana Department of Health and Environmental Sciences.

PCBs are used as coolants in electrical equipment and as components of flame retardants, lubricants, plasticizers, paints and pesticides. They are easily transported through the air and are sometimes found where no apparent waterborne sources are present. PCBs tend to accumulate in the fatty tissues of fish and other aquatic life.

Mercury is present in many forms in natural waters where bacteria can convert it to methylmercury, its most toxic form and the predominant form found in fish tissue. The heaviest mercury contamination is found near industrial sources, but even small quantities originating from natural weathering or atmospheric transport can accumulate in fishes.

Two other Flathead Basin lakes, Mary Ronan and Swan, were included in the survey but were found not to have detectable levels of PCBs in fish. Mercury was present, but not at concentrations considered to be hazardous to human health.

Conclusions

This report has not attempted to thoroughly interpret all the data in the water quality monitoring database. Rather, the researchers involved have identified and analyzed key findings. This progress report pertains to the overall objective of monitoring water quality in the Flathead Basin as detailed in the discussion of the Monitoring Master Plan on page 15 of the Biennial Report.

Much of the water in the Flathead Basin drains out of National Park land and wilderness areas and, in general, waters in the basin continue to rank among the finest in temperate regions of the world. Some lakes in Glacier National Park have the cleanest water documented in scientific literature, and the water quality of Flathead Lake is ranked in the top 10 percent for lakes of its size in the temperate latitudes of the world.

To protect this high quality aquatic system, a variety of monitoring procedures must be continually applied to various water quality variables, and resource managers should be encouraged to use these data in making management decisions.

Although Flathead Basin waters are generally considered to be very clean, trends that identify a deterioration of water quality and a decline in important native fisheries are of concern. The following conclusions highlight aspects of ongoing studies that are being carried out in compliance with the Flathead Basin Commission Master Monitoring Plan.

A. Limnological parameters vary at the mid-lake site in Flathead Lake in comparison to other sites, with the exception of Ross Deep near Big Arm, and, to a lesser extent, at the shallow Lakeside site. Long term data collected at the mid-lake site are representative of the lake as a whole.

B. Ongoing research at the Ross Deep site continues to document reduced dissolved oxygen levels in the bottom layers at the site. Such deterioration of water quality is of significance because hypolimnetic oxygen reduction is an indication of cultural eutrophication, a phenomenon linked to enrichment from nutrient pollution.

C. Because of the high quality waters in the Flathead Basin, aquatic plants and animals have naturally low productivity rates. Increases in productivity rates indicate declines in water quality. Therefore, the lake-wide trend of increasing primary production of phytoplankton (the propensity of the lake to grow algae) is of concern. The trend suggests that algae and other microorganisms in the lake are being fertilized by excess nutrients from the drainage basin and from polluted precipitation that falls on bodies of water throughout the basin.

D. Pollution of Ashley Creek by the Kalispell Sewage Treatment Plant has significantly abated as a result of the installation of new treatment technology and the existence of a ban on the sale of consumer cleaning products containing

phosphorus. However, the sediments of Ashley Creek contain a great deal of phosphorus and nitrogen. Hence, sediment release may somewhat offset improvements in water quality attributable to better sewage treatment, at least for several years.

E. Phosphorus from the urban sewage plants has declined more than 15 percent since 1988 as a result of the implementation of the phosphorus reduction plan of the Montana Water Quality Division. Reduced discharge of P from the waste treatment facilities in the Flathead Basin, a positive development, may be responsible, at least in part, for stabilization of annual primary productivity in recent years.

F. Annual input of phosphorus alone is not enough to predict primary productivity with any accuracy. However, algae growth rates do increase in response to added phosphorus in bioassays of Flathead Lake water. Careful analysis of intra-annual variation is warranted.

G. Tributaries to Flathead and Swan lakes have historically supported what is probably the largest migratory population of bull trout in the world. Unfortunately, bull trout populations have seriously declined in tributaries to the North and Middle forks of the Flathead River. Bull trout populations in the Swan River system, however, are at record highs.

H. The Flathead River system supports one of the most important known populations of genetically pure westslope cutthroat trout. These fish are valuable, unique, and a vital part of the ecological integrity and quality of life in the system.

I. Ongoing monitoring in the Stillwater State Forest suggests that, except for isolated occurrences at Lower Swift Creek, the waters in the Forest appear to be highly suitable for recreational, domestic, fisheries, and irrigation uses. The seasonal flush of high Total Suspended Sediments (TSS) may have no net effect on overall water quality and fish habitat in streams but may have a much greater influence on the waters of Whitefish Lake.

J. The Flathead Basin Commission's Volunteer Monitoring Program provides useful data from 24 lakes in the basin that is of value as a supplement to data gathered through agency, academic, and corporate monitoring efforts.

K. Land owners and managers are increasingly applying Best Management Practices and observing the guidelines of the Streamside Management Zone law. The 1994 audits of BMPs indicate continued improvements over the 1990 and 1992 audit results in the application and effectiveness of BMPs.

Recommendations

The preservation of the quality of life associated with the Flathead Basin and the maintenance of a sustainable economy depend on protecting the current high level of water quality present in the basin. Therefore, the future of the Flathead Basin depends on how well decision-makers understand the damaging effects of certain kinds of human activities and whether they heed the warning signs and adjust management practices accordingly.

1. The Flathead Basin Commission should encourage all relevant entities, including both member organizations of the Commission and others present in the basin, to work cooperatively to respond to the recommendations of this report.

2. Participants in the Monitoring Master Plan are experiencing greater difficulty in maintaining their funding. Appropriate entities, including the Montana Legislature, the U.S. Congress, U.S. EPA, and other state, local, corporate, and public interest organizations should be encouraged to assist the Commission in attaining its monitoring objectives by contributing to the funding of the Monitoring Master Plan.

3. The long-term water quality monitoring program for Flathead Lake should be continued in order to document any changes in the lake's status and to assist the ongoing Total Maximum Daily Load (TMDL) effort. New monitoring is needed to more accurately demonstrate ground water pollution from septic systems on the lake shore, the accuracy of bulk precipitation estimates on a lake wide basis, and the sources of nutrients along the valley sections of the Stillwater, Whitefish, and Flathead rivers.

4. Research should be funded to determine the cause of the hypolimnetic oxygen deficit in Big Arm Bay at the Ross Deep site. Shoreline sources of pollution and the possibility of entrainment of river water in the bay are possible explanations that should be investigated thoroughly. Knowledge of the rate of reduction of oxygen levels at deep lake sites is essential to determining long term trends and understanding the relationship between oxygen reduction and nutrient loading from all sources.

5. The P reduction and TMDL strategy of the Montana Water Quality Division should continue to guide management actions in the Flathead Basin to reduce nutrient pollution. Greater attention should be paid to documentation and reduction of nonpoint sources, especially with respect to increasing fertility of the Stillwater and Whitefish rivers and the Evergreen alluvial aquifer as they flow through the Flathead Valley and discharge into the Flathead River. Additional water quality monitoring sites are needed to determine how land use activities are associated with nonpoint source inputs into these water bodies. Predictive knowledge of sewage leachates from septic systems and soil capacities for new systems is badly needed in view of the rapid growth of homes and businesses outside of the sewer districts in the basin.

6. Efforts by the Commission to develop a water quality management program for the Flathead Basin should be responsive to the conclusions and recommendations of this study. Control of nonpoint sources of nitrogen and phosphorus and the implementation and monitoring of Best Management Practices should be emphasized in all planning processes.

7. The Commission should encourage the application of best management practices for all land use activities in the basin. The primary goal should be to conduct activities in such a manner so as to minimize sediment and nutrient inputs to all basin surface and ground waters. Use of development setbacks, buffer strips, limitations on fertilizer uses, and animal waste and road runoff management systems should be emphasized.

8. The Commission should encourage the funding for the U.S. Geological Survey to maintain its streamflow gauging stations in the basin. The U.S.G.S. monitoring program measures the discharge of Flathead Lake's major tributaries and the data provided is essential to determine such things as flow and pollutant load relationships.

9. The Commission should encourage efforts to develop criteria related to the allowable amount of deposited sediment, percentage of fine sediment, substrate scores, bedload, suspended sediment in critical bull trout and westslope cutthroat trout streams, and relationship to the application of Best Management Practices (BMPs).

10. The Commission should intensify its efforts to inform individuals and organizations about how they can protect water quality in the Flathead Basin. The ongoing process should include efforts to inform the public and private sector leadership and the general public of key findings so all can be involved in assisting in the development of strategies for limiting new and reducing existing pollution sources.

11. The Commission should encourage individuals and organizations to actively participate in monitoring activities through the Volunteer Monitoring Program and other activities which contribute to the overall water quality monitoring and protection effort.

The efforts of the Commission's Monitoring Committee are critical to the monitoring, protection, and preservation of the basin's relatively clean and healthy aquatic environment. Other public and private agencies and organizations and individuals should cooperate and participate to the greatest extend possible to assist the Monitoring Committee in achieving its goals.

Flathead Basin Commission Establishing Legislation

75-7-301. Short title. This part may be cited as the "Flathead Basin Commission Act of 1983".
History: En. Sec. 1, Ch. 424, I, 1983.

75-7-302. Purpose. The purpose of the Flathead Basin Commission is to protect the existing high quality of the Flathead Lake aquatic environment; the waters that flow into, out of, or are tributary to the lake; and the natural resources and environment of the Flathead basin.
History: En. Sec. 2, Ch. 424, I, 1983.

75-7-303. Definitions. As used in this part, the following definitions apply:

(1) "Aquatic resources" means all beneficial uses of water, including but not limited to water quality and water supply; recreational, scenic, and aesthetic values; and fish, wildlife and other organisms.

(2) "Commission" means the Flathead Basin Commission established in 2-15-213.

(3) "Flathead basin" means all land and water areas the water from which drains into Flathead Lake or its tributaries.
History: En. Sec. 3, Ch. 424, I, 1983.

75-7-304. Duties of the commission. Duties of the commission are:

(1) to monitor the existing condition of natural resources in the basin and coordinate development of an annual monitoring plan. This plan must involve a cooperative strategy among all land and water management agencies within the Flathead basin and identify proposed and needed monitoring which emphasizes but is not limited to the aquatic resources of the Flathead basin.

(2) to encourage close cooperation and coordination between federal, state, provincial, tribal, and local resource managers for establishment of compatible resource development standards, comprehensive monitoring, and data collection and interpretation;

(3) to encourage and work for international cooperation and coordination between the state of Montana and the Province of British Columbia concerning the under taking of natural resource monitoring and use of consistent standards for management of resource development activities throughout the North Fork of the Flathead River drainage portion of the Flathead basin;

(4) to encourage economic development and use of the basin's resources to their fullest extent without compromising the present high quality of the Flathead basin's aquatic environment;

(5) to, in the discretion of the commission, undertake investigations of resource utilization and hold public hearings concerning the condition of Flathead Lake and Flathead basin;

(6) to submit a biennial report to the governor and the appropriate committees of the legislature that includes:

(a) a summary of information gathered in fulfillment of its duties under this section;

(b) information on monitoring activities within the Flathead basin concerning the condition of the basin's natural resources, with particular emphasis on Flathead Lake;

(c) the identification of land use and land development trends in the Flathead basin;

(d) any recommendations the commission considers appropriate for fulfillment of its duties and for continued preservation of the Flathead basin in the present high quality of its aquatic resources; and

(e) an accounting of all money received and expended, by source and purpose, for the period since the last report; and

(7) to meet at least semiannually within the Flathead basin, alternating the meeting site between the cities of Kalispell and Polson.
History: En. Sec. 7, Ch. 424, I, 1983.

75-7-305. Commission authority.

(1) The commission may make recommendations to the legislature and the governor and to federal, tribal, provincial, and local agencies for maintenance and enhancement of the quality of natural resources of the Flathead basin.

(2) Subject to appropriation by the legislature, the commission may receive and expend dona tions, gifts, grants, and other money necessary to fulfill its duties.
History: En. Sec. 8, Ch. 424, I, 1983.

75-7-306. Establishment of account. There is established in an other special revenue fund a Flathead Basin Commission account. Money received by the Flathead Basin Commission under 75-7-305 and such other funds as are designated or appropriated for its use must be deposited in the account.
History: En. Sec. 9, Ch. 424, I, 1983, and Sec. 48, Ch. 281, I, 1983.

Compiler's Comments

1983 Amendment Substituted "an other special revenue fund" for "the federal and private revenue fund".

75-7-307. Special county government authority. The governing body of any county within or bordering upon the Flathead basin may allocate to the Flathead Basin Commission a por- tion of any money available from coal severance tax allocations or other sources and desig nated for planning activities.
History: En. Sec. 10, Ch. 424, I, 1983.

75-7-308. Cooperation with other agencies and organizations. To fulfill its duties, the Commission shall develop and maintain cooperative programs with federal, state, provincial, tribal, and local agencies or organizations that are responsible for natural resource manage ment and monitoring in the Flathead basin. Participating federal and provincial agencies must be requested to provide adequate funds to participate on the Commission and to monitor resources within their areas of responsibility.
History: En. Sec. 11, Ch. 424, I, 1

Glossary

Acid precipitation — All forms of precipitation that have an acidity lower than normal rainfall (pH 5.6).

Acre-foot — The amount of water needed to cover one acre of surface area to the depth of one foot (12 inches).

Algae — Simple one-celled or many-celled plants, capable of photosynthesis; usually aquatic.

Analysis of covariance — A statistical procedure that examines the relationship between two or more measures simultaneously (i.e., one dependent variable and one or more independent variables).

Aquatic — Plants or animal life living in, growing in, or adapted to water.

Available nutrient — That portion of any element or compound (such as phosphorus and nitrogen)in the soil that can be readily absorbed and assimilated by growing plants.

Best Management Practices (BMPs) — Methods, measures, or practices to prevent or reduce water pollution.

Biochemical Oxygen Demand (B.O.D.) — The quantity of oxygen utilized in the biochemical oxidation of organic matter in a specified time and at a specified temperature. Waste discharges containing high levels of B.O.D. will deplete oxygen supplies in receiving waters.

Biological availability — Refers to the form that a substance or compound can take that can be readily used for plant or animal growth. Depending on their chemical structure, certain compounds are more available for plant growth than others.

Buffer strip — Strips of grass or other erosion-resistant vegetation between a waterway and an area of more intensive land use.

Data base — A collection of information kept in accessible form for purposes of research, comparison and analysis.

Dissolved Oxygen (DO) — The amount of free oxygen dissolved in water and readily available to aquatic organisms.

Effluent — Liquid attributed to human waste, i.e. sewage arising from various uses of water; often refers to waste water from a sewage treatment or industrial plant.

Erosion — The removal or wearing away of soil or rock by water, wind or other forces or processes. Erosion occurs naturally from weathering or runoff, but can be intensified by land clearing practices.

Eutrophication — The addition of nutrients to a body of water. Accelerated by human activities, abundant growth of aquatic plants may consume much of the dissolved oxygen, making the lake uninhabitable for the previous diversity of fish and other aquatic life.

Fluvial deposits — Sediments deposited by river action.

Fresh water — Clean, unpolluted water without salinity.

Groundwater — The supply of fresh water that forms a natural reservoir under the earth's surface in soil and bedrock.

Groundwater recharge	The natural renewal of ground water supplies by infiltration of rain or other precipitation through the soil .
Hydrology	The area of science dealing with the study of the waters of the earth and its atmosphere.
Leaching	The removal of nutrients, chemicals or contaminants from the soil by water movement through the soil.
Limnology	The area of science dealing with the study of freshwater aquatic ecology.
Mass flux	The input or gain and output or loss of materials (such as nutrients) to an area such as a body of water.
Mass wasting	A general term for a variety of processes by which large masses of earth material are moved by gravity either slowly or quickly from one place to another.
Mesotrophic	Descriptive of lakes in transition from oligotrophic status toward eutrophic. They are still generally pristine, but fish species are mixed, nutrient levels are higher and water is not quite as crystal clear.
Nitrogen	A chemical element used in fertilizer as a nutrient (also a component of animal wastes). It can promote algal blooms that cause eutrophication if it runs off or leaches out of the surface soil.
Nonpoint source	A diffuse source of water pollution that does not discharge through a pipe. This may be agricultural or urban runoff, or runoff from construction activities.
Nutrient budget	The quantity of a given element or compound available for plant productivity over time. Changes in plant productivity are directly related to changes in the nutrient budget.
Nutrient loading	Increases in the nutrient budget attributed to either increases from human-related or natural events.
Oligothrophic	Descriptive of crystal-clear lakes characterized by cold water fish species, low nutrient content and generally pristine features.
Ortho phosphorus	The form of phosphorus most available to algae for growth.
Particulate organic carbon	Carbon content of particles in the water derived from living organisms (includes algae, waste products, dead or decayed organisms).
pH	A measure that indicates the relative acidity or alkalinity of a substance. The pH scale ranges from 0 (most acid) to 14 (most basic), with a pH of 7 being neutral.
Phosphorus	One of the primary nutrients required for the growth of aquatic plants and algae. Phosphorus is often the limiting nutrient for the growth of these plants. (See nitrogen)
Point source	Discernible sources of pollution, such as pipes, ditches, channels, wells, containers, concentrated animal feeding operations, or other vessels.
Primary productivity	The ability of a body of water to grow algae.
Revegation	The planting of ground cover on highly erodible and marginal lands as a means of preventing further erosion.

Riparian Located or living along or near a stream, river or body of water.

River hydrograph The pattern of a river or lake expressed as in-flow and out-flow ratios (such as cubic feet per second) and containing temperature, chemical and other expected characteristics.

Runoff Water from rain, snow melt, or irrigation that flows over the ground surface and returns to streams. It can collect pollutants from air or land and carry them to the receiving waters.

Sediment Solid material (silt, sand, or organic matter) that has been moved from its site of origin and has settled to the bottom of a watercourse or water body. Excessive amounts can clog a watercourse. If disturbed, it can contribute to turbidity.

Solubility The capacity to be dissolved or liquefied.

Suspended solids Solids floating in the water column that generally impart a cloudy appearance to water, sewage, or other liquids.

Trophic status The descriptive phase of a lake: oligotrophic, mesotrophic, eutrophic or somewhere in between. (Flathead Lake currently is described as oligo-mesotrophic).

Turbidity Haziness or cloudiness in water because of suspended silt or organic matter.

Water column A cross section of a body of water from a point on the surface, straight down to the bottom.

Water cycle The continuous circulation of water in systems throughout the planet, involving condensation, precipitation, runoff, evaporation and transpiration.

Watershed The area of land that drains into a particular watercourse or water body.

Wetlands Any land area that tends to be regularly wet or flooded.

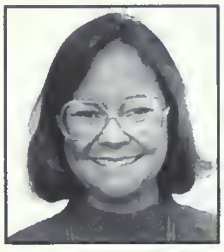
Zooplankton Plankton that is composed of tiny animals and animal matter.

Members of the Flathead Basin Commission

Larry Wilson
Chair
Citizen Member
Columbia Falls

Jerry Sorensen
Citizen Member
Kalispell

Marilyn Wood
Citizen Member
Bigfork



Elna Darrow
Vice Chair
Citizen Member
Bigfork

William Gregg
Citizen Member
Polson

Joel Holtrop
Supervisor
Flathead National Forest
Kalispell

Glenn Marx
Executive Director
Office of the Governor
Helena

Colleen Allison
Citizen Member
Columbia Falls

David Mihalic
Superintendent
Glacier National Park
West Glacier

Bill O'Brien
Area Manager
Montana Dept. of State Lands
Kalispell

Forrest Sanderson
Land Services Department
Lake County
Polson

Sharon Stratton
County Commissioner
Flathead County
Kalispell

Rhonda Swaney
Council Vice Chair
Confederated Salish &
Kootenai Tribes
Pablo

Steven Foster
Ex-officio Member
U.S. Army Corps of Engineers
Seattle

Dan Vincent
Ex-officio Member
Regional Supervisor
MDFWP
Kalispell

Dr. Loren Bahls
Ex-officio Member
MDHES Water Quality Division
Helena

Gail Kuntz
Ex-officio Member
Bonneville Power Administration
Helena

Dennis McDonald
British Columbia Liaison
Regional Supervisor
B.C. Environment
Nelson

Robert O'Leary
Ex-officio Member
Montana Power Company
Butte

Rich Moy
Ex-officio Member
Water Management Bureau
MDNRC
Helena

Dennis Christenson
Ex-officio Member
Superintendent
U.S. Bureau of Reclamation
Hungry Horse Project
Hungry Horse

Wiliam Engle
Ex-officio Member
U.S. Environmental Protection
Agency
Helena

Mark Holston
Public Information Officer
Kalispell

Commission Budget

The Flathead Basin Commission receives state funding from the Resources Indemnity Trust Tax Water Development Fund. In addition, the Commission actively seeks financial, in-kind and volunteer support from other sources. The information below summarizes sources of funding, contributions received, and how financial resources were allocated for the 1993-1994 biennium, and is intended for general informational purposes only.

Funding	Sources
RIT Water Development Fund	$81,000
Bonneville Power Administration Grant	12,500
U.S. EPA Clean Lakes Grant	17,000
Crown of the Continent Ecoregion Workshop Grant	4,500
Flathead County	1,800
Total Funding Assistance	$116,800

Funding Allocations	
Staffing	$68,000
Office Operations	
Communications	6,500
Supplies and Materials	3,500
Projects	1,500
Equipment	1,500
Travel	2,500
Other Expenses and Services	3,000
Office Rent	1,800
Crown of the Continent Ecoregion Workshop	4,500
Volunteer Monitoring Program	17,000
Biennial Report preparation and publishing	7,000
Total Expenditures	$116,800

In-kind and Volunteer Assistance	
Green Thumb Program	1,000 hours
Volunteer Monitor Program participants	700 hours

Scientific Report Section

This Water Quality Monitoring Report is derived from various research documents and from discussions with the researchers. The basic reports from which information was taken include:

"Diagnostic Analysis of Annual Phosphorus Loading and Pelagic Primary Production in Flathead Lake, Montana — Flathead Lake Clean Lakes Project, Phase One. Open File Report 132-94" (By Jack A. Stanford, Bonnie K. Ellis, Drury G. Carr, Geoffrey C. Poole, James A. Craft and Dale W. Chess, Flathead Lake Biological Station, The University of Montana, April 1, 1994)

"Flathead Basin Commission: Biennial Report Water Quality Monitoring — Headwater Streams (By Liz Hill, Flathead National Forest, 1994)

"Flathead Basin Commission: Biennial Report Water Quality Monitoring —Lower Flathead River Basin/Flathead Indian Reservation" (By Dave Haire, Water Quality Program, Confederated Salish & Kootenai Tribes, 1994)

"Monitoring Fisheries Habitat and Fish Populations in the Flathead Basin" (By Tom Weaver, Montana Department of Fish, Wildlife and Parks, 1994)

"Surface Water Quality of the Stillwater State Forest" (By Mark D'Aversa, Forestry Division, Montana Department of State Lands, November 1994)

"Water quality-Related Activities by Plum Creek Timber Company in the Upper Flathead River Basin, 1992-1994 (By Brian Sugden, Plum Creek Timber Company, 1994)

"Lake Water Quality Assessment and Contaminant Monitoring of Fishes and Sediments from Montana Waters" (Water Quality Division, Montana Department of Health and Environmental Sciences, 1994)

"1994 Forestry BMP Audits Final Report" (Montana Department of State Lands, 1994)

NOTES

NOTES

NOTES

Report Production Credits

Editing and Photography
Mark Holston

Water Quality Monitoring Editing
Conner Inc.

Design and Layout
Dog Sonic

Lithography
Digital Planet

Printing
Printing Center

Cover Illustration
Sasha Smith
Student,
Flathead High School

The contributions of Cath Althen, Liz Hill, Lynda Holmquist and Clare Ellen Anderson are gratefully acknowledged.

PUBLISHED BY
Flathead Basin Commission
723 Fifth Avenue East
Kalispell, Montana 59901

406.752.0081
406.752.0095 FAX

1,000 copies of this public document were published at an estimated cost of $1.75 per copy, for a total cost of $1,750, which includes $1,750 for printing and $.00 for distribution.

Printed on Recycled Paper